

Transforming Learning for the 21st Century: An Economic Imperative

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Foreword

This document was developed as a terminating activity of the North Central Regional Technology Consortium (NCRTEC), which after 13 years of existence concluded on September 30, 2005. People who were served by NCRTEC requested guidance and recommendations on making information and communication technology (ICT) use in education centered on the future needs of students and society. After discussions with state technology directors in the NCRTEC region and additional communications with many educators of varying responsibilities, NCRTEC staff determined that a writing team consisting of experts in education and economics would work with a distinguished panel representing business and education to determine perspectives and recommendations to present about education, economic development, and ICT. The writing team, led by Chris Dede, Wirth Professor in learning technologies at Harvard University, was charged with developing a preliminary draft to provide a common experience and a starting point for the discussions. As the membership list documents, the panel was both distinguished and national in scope. The group represented various kinds of expertise and included people with work experience at major corporations; federal, state, and local governments; national organizations; and many types of educational institutions. In addition to the expert panel, the writing team found the publications of Dr. Robert Kozma (cited in the report) very helpful in evolving its thinking.

The Writing Team and the Expert Panel met in August 2005. The two-day meeting was both sobering and exhilarating, as it became apparent that our nation must look beyond changes in school, pedagogy, and information technology use to more sweeping shifts in other types of societal institutions. Very quickly, the panel and writing team determined that larger economic and social issues facing the United States required more meaningful partnerships and attention to systemic educational reform that information and communication technology (ICT) use could assist, but not in itself resolve.

Based on these discussions, the writing team revised its preliminary report, and that set of ideas is presented in this document. The writing team is very grateful to this expert panel for their detailed feedback on the preliminary report and the many ideas they contributed. Any errors, misinterpretations, or omissions in this report are the responsibility of the writing team and not the expert panel. It should be noted that, while this document is a clarion call for a new approach to teaching and schooling, it is rooted in a clear understanding of the culture of schools and grows out of those existing parameters toward a model that will better prepare students for the demands of the 21st century economy.

This document has two components. The first section is a seven-page executive summary that briefly captures perspectives and recommendations evolving from the thinking of the expert panel and the writing team. The second section is a more lengthy and detailed analysis of issues, challenges, and suggested strategies. We hope that this report is useful to you—not as a source of proven answers, but as a means of stimulating thinking and discussion about new approaches for using ICT to simultaneously advance educational quality and economic prosperity and security.

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Executive Summary

The New Economy: Will the U.S Remain Competitive?

The next decade will determine the future of the U.S. economy for generations to come. Never before has the United States faced global competition of the magnitude seen today. Whole industries, such as steel and paper, that were once U.S.-owned and world-dominant are now headquartered in China and Sweden (Stiglitz, 2002).

Market-based competition is coming from every corner of the world (Lall, 2002). Rising economies in Asia based on cheap natural resources and inexpensive labor have stripped the United States of its dominant role in manufacturing. Nationally subsidized research and development in Europe and Asia are eroding the historic scientific and technological advantage of the United States (Friedman, 2005b). Countries such as the Czech Republic and Poland have copied the American dream and freed their workers to compete for global markets (Ranis, 2004). And countries such as South Korea, Ireland, and Finland have advanced their global economic reach by investing in education that leverages learning technologies to prepare sophisticated workers (Blomstrom, Kokko, & Sjöholm, 2002).

A recent report, *Tapping America's Potential: The Education for Innovation Initiative*, issued by the Business Roundtable (2005) expresses “deep concern about the United States’ ability to sustain its scientific and technological superiority through this decade and beyond” (p. 1) The report calls for a sense of urgency and for immediate action to secure a prosperous future for our country and our children.

The 21st century has brought with it a dramatic shift in the economic model for industrialized countries. Systems of economic development based on geography, trade rules, and tariffs; slow dissemination of scientific and technological discoveries; and long cycles of product life have given way to global trade, rapid product innovation, the lowering of trade barriers, rapid dissemination of scientific and technological discovery, and rapid global deployment and movement of capital and the means of production (Chang, 2003). In the 21st century, income and wealth come from applying technology and new ideas to create new products and processes. Adding value to products and processes is the key to growing jobs and incomes in this new economic environment (Aubert & Reiffers, 2004).

In this new economic environment—the New Economy—education plays a critical role in maintaining prosperity and stimulating economic growth (Stevens & Weale, 2003). The level of workforce skills and the periodic need to update those skills are both rising in the New Economy (Temple, 2001). Nations and workers must be prepared to shift jobs and careers more frequently, to be flexible and adaptable in acquiring job skills, and to integrate and focus a changing mix of job and education skills on business processes and problems (Barro, 2000).

Competitive advantage for a region, state, or nation is now built on the skills of its general workforce as opposed to its geography, trade laws, research labs, and patents. And critical to that competitive advantage are the education and skills training adults acquire in primary and secondary schools (Organization for Economic Co-operation and Development, 2001).

Education has many responsibilities other than aiding economic development, and this report does not attempt to portray the full range of educational missions or the strategies needed for success across this spectrum of goals. However, all those other responsibilities are possible only if education succeeds in providing the foundation for a prosperous future. This does not mean that education for economic development is privileged more than other objectives. However, those who want education to succeed in resolving major concerns (e.g., equity, developing moral citizens, preparation for self-realization) need to incorporate perspectives about preparation for 21st century work into their planning.

Achieving U.S. Prosperity and Security in the New Economy

For the first time in centuries, there is doubt that future generations will be as economically prosperous as their parents. Rising income levels in the 20th century led to a better life for succeeding generations. That prosperity also led to a sense of personal security and the economic means to assure national security.

The “churn” in job roles characteristic of the New Economy—caused by rapid technological change, sudden shifts in corporate fortunes, the outsourcing of jobs to other countries, and job losses due to rapidly improving productivity—has unsettled the American people. Despite good employment numbers and strong economic growth following September 11, 2001 (9/11), and a short economic recession, a sense of economic confidence has not returned. Hurricanes Katrina and Rita in 2005 also will impact the improvement of the U.S. economy.

Workers today face a new set of challenges and uncertainties. The evolution of the New Economy has led to job losses in manufacturing and industrial businesses and a surge in job openings in health care, services, and technology. However, these new jobs are different in the working conditions and salary level than the jobs that have disappeared. Some new jobs are high-paying and demand sophisticated skills and knowledge, but most have low wages and benefits, marginal working conditions, and little security (Ehrenreich, 2001). As the New Economy continues to evolve and churn, predictions are that workers will change jobs seven or eight times during their work life. To be competitive in this New Economy career churn, workers will have to engage in lifelong learning to update their education and job skills (Card & Dinardo, 2002).

A related characteristic of the New Economy is a widening gap in income levels based on skills and educational attainment (Levy & Murnane, 2004). In the last two decades of the 20th century, the real annual income gap between those with a high school degree and those with a college degree nearly doubled. The incomes of less educated workers have shown no real growth while the real earnings of better-educated workers have climbed dramatically, causing a huge income gap. Throughout an average work life, the gap in lifetime earnings between those with only a high school degree and those with a college degree has increased from about \$500,000 in the 1981 to nearly a million dollars in 2001.

The application of information technology to the very core of business operations has caused a profound change in the needed skills and talents of New Economy workers (OECD, 2004). Markets in the New Economy are rewarding those who have high educational achievement and technical skill (Task Force on the Future of American Innovation, 2005). The worker of the 21st

century must have science and mathematics skills, creativity, information and communication technologies (ICT) skills, and the ability to solve complex problems (Business-Higher Education Forum, 2005).

Clearly, the future personal economic security and well-being of American workers is tied to educational achievement (Federal Reserve Bank of Dallas, 2004). And yet the rate at which high school graduates are going on to postsecondary education is falling, not rising. Our country is losing vital talent because our current educational system neither engages many students nor helps them succeed. Failure to address our dropout crisis will lead to dismal economic results in the years ahead.

Missed Opportunities for U.S. Education to Leverage the Power of ICT

The New Economy is driven by entrepreneurs, technology, and innovation. Novel ideas, discoveries, and technologies have produced whole new industries and products; innovation is now the primary basis for income and wealth generation (Sianesi & Van Reenan, 2002).

Globalization has forced business to drive rapid technological change into the very core of business operations and processes (Bhagwati, 2004). Early efforts to improve productivity in business were aimed at applying technology to administrative and processing applications, such as purchasing, accounting, and payroll. These applications of technology changed the speed of work, but not the fundamental nature of work. As the New Economy took hold, the complexity of business dramatically increased. Global markets, just-in-time manufacturing and product fulfillment, outsourcing, lean manufacturing, and other changes forced fundamental changes in the nature and complexity of work (Autor, Levy, & Murnane, 2003). ICT applied to the core functions of business resulted in huge gains in productivity and the ability to manage and solve complex problems (Brown & Duguid, 2000).

Until now, education has applied ICT aggressively to administrative tasks and processes and has experimented with learning technologies as a means to improve students' educational outcomes. However, the fundamental way of educating students has not changed to match the dynamic change in the economy. For example, ICT has not been systematically incorporated into the core learning processes in teacher education and curricular reform.

Much of U.S. education is still based on the premise that economic processes and institutions will mirror those in the 20th century. Students are prepared to be future employees of business organizations now rapidly becoming obsolete. Current trends suggest that more students will run their own businesses rather than work for others and as adults must constantly, quickly, and efficiently learn new skills and information to be effective entrepreneurs. To succeed in life and to keep our country strong and prosperous, all of today's students must graduate able to deal with ambiguity and capable of higher order analysis and complex communication.

A primary challenge for U.S. education is to transform children's learning processes in and out of school and to engage student interest in gaining 21st century skills and knowledge. Education must align curriculum and learning to a whole new economic model. Linking economic development, educational evolution, workforce development, and strengthened social services is

essential to meeting this challenge. The use of sophisticated information technologies in every aspect of education can provide a powerful lever for this transformation (Jones, 2003).

Isolated in their classrooms from the rest of society, teachers often have little idea of the skills and knowledge required for adept performance in high-technology workplaces. Economists Levy and Murnane (2004) document how:

Declining portions of the labor force are engaged in jobs that consist primarily of routine cognitive work and routine manual labor—the types of tasks that are easiest to program computers to do. Growing proportions of the nation’s labor force are engaged in jobs that emphasize expert thinking or complex communication—tasks that computers cannot do. (pp. 53–54)

These economists go on to explain that “expert thinking [involves] effective pattern matching based on detailed knowledge; and metacognition, the set of skills used by the stumped expert to decide when to give up on one strategy and what to try next” (Levy & Murnane, 2004, p. 75). “Complex communication requires the exchange of vast amounts of verbal and nonverbal information. The information flow is constantly adjusted as the communication evolves unpredictably” (Levy & Murnane, 2004, p. 94).

Effective teachers engage in expert thinking and complex communication related to instruction, so they know about highly skilled work in their own context. However, these skills as applied in a classroom setting with children are quite different than expert thinking and complex communications applied in 21st century workplaces with adults. (This is why skilled workers do not necessarily transition to classroom teaching with instant effectiveness and why adept teachers may require a period of training and adjustment when shifting careers into workplace roles.) For teachers to model skills of adult thinking and communication to children at a level youngsters understand requires sophistication both about adult performance in workplace settings and about the ways children understand the world around them. Effective teachers have the latter, but need frequent access to and immersion in our economy’s rapidly evolving workplace contexts to keep current with the former.

In addition, rapid advances in ICT are reshaping the learning styles of many students. For example, by its nature the Web rewards comparing multiple sources of information, individually incomplete and collectively inconsistent. This induces learning based on seeking, sieving, and synthesizing rather than on assimilating a single “validated” source of knowledge as from books, television, or a professor lecturing. Overall, the Internet-based learning styles ascribed to “millennial” students born after 1982 are increasingly true for many people across a wide range of ages, driven by the tools and media they use everyday.

In addition, as computers and telecommunications continue to evolve, new forms of “neomillennial” learning styles are emerging. Research on sophisticated interactive media suggests that the following may emerge as cross-age learning styles (Dede, 2005b):

- Fluency in multiple media, valuing each for the types of communication, activities, experiences, and expressions it empowers
- Learning based on collectively seeking, sieving, and synthesizing experiences rather than individually locating and absorbing information from some single best source
- Active learning based on experience (real and simulated) that includes frequent opportunities for reflection
- Expression through nonlinear, associational webs of representations rather than linear “stories” (e.g., authoring a simulation and a Web page to express understanding rather than a paper)
- Codesign of learning experiences personalized to individual needs and preferences

These trends have a variety of implications for how students can acquire 21st century knowledge and skills through pedagogies and media that engage their interests, build on strengths from their leisure activities outside of school, and speak to their learning styles.

Linking Our Nation’s Educational Evolution and its Economic Development

The transformation of learning in many other countries provides models to consider how linking education and the economy benefits students, businesses, and society (Kozma & Voogt, 2003). Such a linkage only can take place through educators engaging in a strategic partnership with business and government sectors that transforms planning and decision making in all three sectors (Hepp, Hinostroza, Laval, & Rebein, 2004).

Kozma (in press) cites three case studies of countries engaging in ICT-based education reform. His case studies include two developed countries, Finland and Singapore, and one less developed country, Egypt. Each country in the case studies had to craft a unique approach to spurring economic development through ICT-based education reform. Some of the lessons from those cases include the following:

- Singapore was able to sustain rapid economic growth in the last two decades of the 20th century by tapping into global markets and by pursuing a strategy of moving from low value-added exports to high value-added manufacturing. As global competition increased, Singapore found itself challenged by competing developing nations following the same strategy, taking market share away from Singapore. To maintain economic growth, the country needed to change strategies by increasing research and development as well as entrepreneurial activity to engage growth in new high-value industrial clusters, such as nanotechnology and micromechanical systems. To accomplish this change, Singapore adopted educational policies that enhanced the skills and creativity of its labor force. Through its centralized educational structure, Singapore was able to implement change in a coordinated fashion with other government ministries. A key driver for the change was a five year ICT plan, *Master Plan for IT Education*, that emphasized linkages

between schools and the world around them and that encouraged educational outcomes such as creative thinking, lifelong learning, and social responsibility.

- Finland has transformed its economy from a raw materials-based manufacturing economy to one with high concentrations in high-tech fields, with a particular focus on telecommunications. The impetus for change in Finland was a period of economic recession in the early 1990s that caused the government to shift economic development policy to support higher valued-added, high-tech industries. Finland today has a robust economy with leading global companies such as Nokia and is regarded as one of the most competitive industrial economies. To accomplish this, Finland used a decentralized approach that linked the educational system to the civic and business community. Finland has a broad vision for the future to build a Finnish Information Society that emphasizes lifelong learning, the building of education and research networks, and the development of information products and services.
- Egypt is a less developed country that is trying to transition from a state-directed economy to a less regulated market economy. The country has a high poverty rate and a low literacy rate. Recent measures proposed by the government are aimed at improving the overall education level of the country and changing its education system from its current focus on rote memorization. Government actions have encouraged ICT-based development and have supported the development of an ICT export cluster. The government is supporting the purchase of home computers, low-cost access to the Internet, expanded broadband services, and the development of local internal technology clubs. Egypt continues to seek educational reform strategies that can bring about sustained change and a linking of the education system to economic development.

Other nations that are investing at-scale, long-term, and strategically include the following:

- **South Korea.** “Today some three quarters of South Korean households have broadband Internet hookups. Of the population of 48 million, 80 percent carries a mobile phone Many of these phones are equipped with cutting-edge technology allowing the users to take photos, surf the Net, and listen to music. But other nations are narrowing the gap. So the government has launched a program designed to propel Korea ahead of the pack. It’s called ‘IT839’—shorthand for the eight services, three infrastructure projects, and nine new or upgraded devices the country’s tech wizards have decided to focus on over the next five years.” (Ihlwan, Edwards, & Burrows, 2005)
- **Ireland.** Ireland is ‘playing offense’ ... the country has started a campaign to double the number of Ph.D.s it graduates in science and engineering by 2010; and it has set up various funds to get global companies, and just brainy people, to come to Ireland to do research. Ireland is actively recruiting Chinese scientists in particular. (Friedman, 2005a, p. 17)

Unfortunately, the types of coordinated educational, economic, and social investment policies Kozma’s framework (Appendix A) suggests have largely disappeared from the U.S. national agenda. In particular, building ubiquitous public access for fundamental, standards-based technologies (e.g., universal wireless service as a public good comparable to universal telephone service) is now not seen as a priority for improving education, building workforce capacity, or

enhancing the social and economic integration of groups with diverse cultural backgrounds into our society. In addition, initiatives to develop and validate sophisticated technologies to increase learning success for K–12 children are now phasing out as federal and state political agendas for education reform have shifted to emphasize basic skills focused more on industrial workplaces than global, knowledge-based economies.

In contrast, this report proposes a rationale and initial steps for shifting to a 21st century agenda for educational improvement within the larger context of economic and social development. This document builds on the trends and research-based evidence discussed above to suggest possible strategies for change. These strategies are not yet based on proven methods (empirical research on this challenging situation is in its early stages), but instead on informed judgments by a range of experienced professionals familiar with educational and economic dynamics. This report's objective is to stimulate dialogue and debate about the true nature of the challenges U.S. education faces and the powerful ways ICT could aid in meeting those challenges.

How can K–12 educators prepare today's children for success in tomorrow's world? Not by conducting business as usual. Reading and mathematics are fundamental to developing effective communication skills, and rudimentary historical knowledge is necessary for understanding the current context. But this report is not a recommendation for yet another bandage focusing solely on basic skills that are foundational, but woefully insufficient for a quality job and fulfilling life in the 21st century.

Instead, this document is a call for thoughtful and fundamental change in how the business sector, K–12 education, and workforce development organizations conduct their part of the economic equation. The only way to construct such a shift will be through intentional outreach and collaboration by educators with all constituencies who have fundamental roles in the development of children and tomorrow's workforce.

In particular, business and education cannot continue to operate as if they are in an estranged marriage. The interdependence of both, coupled with the economic and workforce governance roles of elected and other community leaders, must advance to new 21st century models. Furthermore, these models must facilitate long-term, strategic planning. Our society can no longer afford to continue working in slow, advancing and receding cycles of political change and ideological conflict.

The recommendations that follow are based on a more detailed analysis of education, economic development, and ICT delineated in the second section of this document.

Recommendations

The following are key recommendations developed by the expert panel and writing team for transforming learning for the 21st century and for improving our nation's economic competitiveness.

Action Plan for U.S. Economic Development: The K–12 Education Factor

Educating the Public, Students, and Educators on the New Economy and its Impact on Education and Lifelong Learning (p. 10)

The next decade will determine the future of the U.S. economy for generations to come, as global competition is eroding our historic scientific and technological advantages. Education for 21st century work and citizenship is the vital resource in this international race for the economic high ground. But current 20th century models of U.S. education fall short in preparing this country's students for a knowledge-based, worldwide economy. Evolving to 21st century educational models requires new types of immediate, coordinated action by our nation's business, education, and policy sectors.

Constructing a Framework for Economic Transformation (p. 14)

Many educational practices that have evolved to meet the nation's needs during the 20th century will not serve the country well in the 21st century. Our society must have the courage to transform the traditional K–12 education models to better serve the needs of the children and the nation. New, powerful, sustained partnerships are required to guide this necessary work, an arduous transformation fraught with potential pitfalls and traps.

Vision, Structure and Leadership to Align Education and Economic Development (p. 16)

The power for transformation can emerge from the intersection of organizations (business, education, government) that traditionally coexist, but are not engaged in genuine collaboration. Creating a shared vision that engages key leaders in various sectors of society over time is vital to enabling transformation to 21st century learning. This requires a new type of leadership. Who would serve? How should this work be supported? What are some early tasks to address? What are key attributes for those leading this work?

Enabling Learning for the 21st Century (p. 26)

While much is known about how to help students learn fundamental educational skills, the nation is having limited success at reaching all children. Powerful, proven models for transforming children's learning processes in and out of school and for enabling students' acquisition of 21st century skills and knowledge are largely lacking. More than ever before, today's children need to have learning experiences embedded in a context where the relevance of their studies to their future is apparent.

Leveraging Data, Policies and Practices (p. 40)

Sophisticated, industry-proven tools for data collection and analysis are now available for use in schools and classrooms. Research about what data will inform learning and increase student success is in its early stages. Data-based decision making will affect every segment of K–12 schooling from preservice and instruction to research and administration. Almost all practicing educators and their teachers have learned their craft using 20th century decision-making models. Our society should undertake an intentional, large-scale transition creating the capacity for current and new educators to lead communities and the nation toward the future, not to reinforce their past. The nation should infuse new models for teaching and learning based upon effective research-based models.

Educating the Public, Students, and Educators on the New Economy and its Impact on Education and Lifelong Learning

Education, Training, and the Workforce in the 21st Century: The Role of Schools in the New Economy

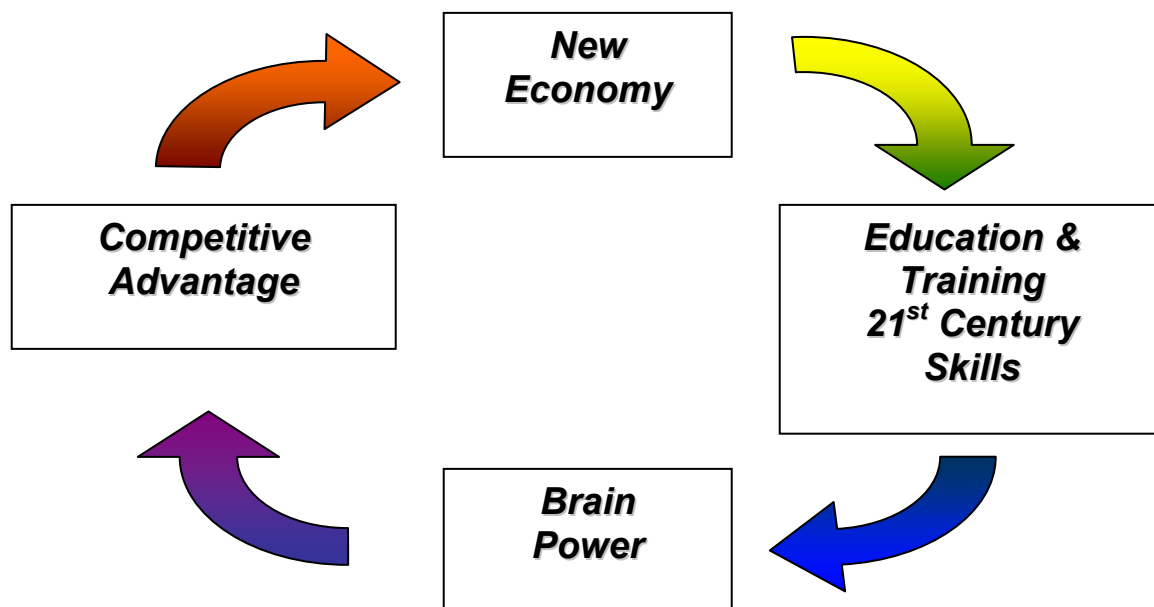
The 21st century has brought with it a dramatic shift in the economic model for industrialized countries. Systems of economic development based on geography, trade rules, and tariffs; slow dissemination of scientific and technological discoveries; and long cycles of product life have given way to global trade, rapid product innovation, the lowering of trade barriers, rapid dissemination of scientific and technological discovery, and rapid global deployment and movement of both capital and the means of production (Soros, 2002).

In this new economic environment, the New Economy, education plays a critical role in maintaining prosperity and stimulating economic growth. The level of workforce skills and the periodic need to update those skills are both rising. Workers must be prepared to shift jobs and careers more frequently, to be flexible and adaptable in acquiring job skills, and to integrate and focus a changing mix of job-specific and educationally generic skills on business processes and problems (Wheeler, 2005).

Competitive advantage for a region, state, or nation is now built on the skills of its general workforce, as opposed to its geography, trade laws, research labs, and patents. Critical to that competitive advantage is the education and skills training acquired in the primary and secondary schools. A visualization of this flow is represented in Figure 1.



Figure 1. Flow Critical to Competitive Advantage



The New Economy is forcing a change in thinking with regard to economic, workforce, and business planning. For some time, competition has forced U.S. businesses to think globally and to acquire the assets needed to trade on a worldwide basis. Businesses regularly acquire capital, raw materials, manufacturing capacity, and workforce skills across the globe. This has led to consolidation of manufacturing and services operations and the outsourcing of some production and service delivery to keep competitive advantage. The closing of outmoded production facilities, the application of new technologies, and migration of manufacturing and service delivery outside the nation has led to massive increases in productivity, but also to worker dislocations and job losses.

This shift in the business sector has forced changes in economic development planning. In localities, plant consolidations and job losses due to new technologies have generated political pressures for economic development programs aimed at creating more jobs. However, as global competition has accelerated, the scale of economic problems faced by individual towns and cities exceeds their capacity to solve those problems locally. Challenges such as workforce training and retraining, increasing available seed investment capital, building telecommunications and other infrastructures, and supporting entrepreneurial activity require regional cooperation and planning. The scale of economic development problems and opportunities and the level of investment needed to solve those problems and take advantage of those opportunities continue to increase as global competition grows.

This shift in regional economic development planning is mirrored by changes in workforce training and planning. As businesses require new skills to stay competitive, workforce development boards and state workforce departments struggle to identify both training or education needs and providers to take care of those needs. Both the dislocation of workers due to plant consolidations and outsourcing and the increasing mobility of the workforce create challenges that require policies coordinated across an entire region.

Inter-sector organizational structures that create opportunities to nurture and sustain scalable improvements are needed. One collaborative that contains many of the essential elements for the broad-scale action called for in this report is the Southern Growth Policies Board (n.d.) (www.southern.org). Their mission statement features relationships among business, education, and the public sector:

Southern Growth Policies Board is a nonpartisan public policy think tank based in Research Triangle Park, North Carolina. Formed by the region's governors in 1971, Southern Growth Policies Board develops and advances visionary economic development policies by providing a forum for partnership and dialogue among a diverse cross-section of the region's governors, legislators, business and academic leaders and the economic- and community-development sectors. This unique public-private partnership is devoted to strengthening the South's economy and creating the highest possible quality of life. (p. 1)

Regional bodies such as Southern Growth Policies Board can create the critical mass needed to advance major initiatives while remaining attuned to local strengths and needs. Such structures are necessarily regional because individual communities do not have the capacity to shape and develop all the requisite dimensions of change. However, building on the collective strengths of

a region can create new opportunities for engagement. This requires identifying the needs and developing the opportunities posed by urban and rural communities, each having complex variables to consider.

In this rapidly changing global and local environment, schools face the challenge of preparing students for the global economy. Schools must anticipate the changes in desired workforce skills and knowledge that are occurring and revise their curriculum, facilities, technology infrastructure and usage, and teacher professional development accordingly. The rapid pace necessary for these essential shifts conflicts with the ordinary, gradual processes of change in schools. The traditional nature of schooling—with semester-based scheduling; slow changes in curriculum; and limited, reluctant acquisition of technology—are examples of the conflict between the high speed of external changes and the glacial nature of school innovation processes.

An additional, related challenge facing schools is the networking and information flow with the business, workforce training, and economic development sectors. Schools often are at the margins of communications among these groups. The graphics below depict the networking and information flow among these sectors as it is now, shown in Figure 2, and as it should be to achieve a robust, growing regional economy, shown in Figure 3.

Figure 2. Current Networking and Information Flow

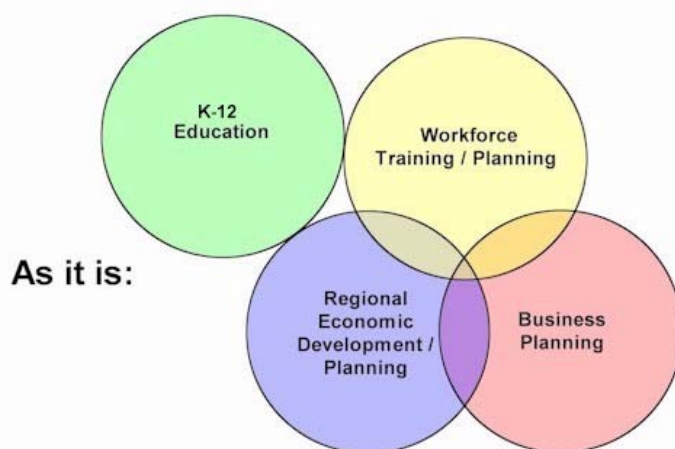
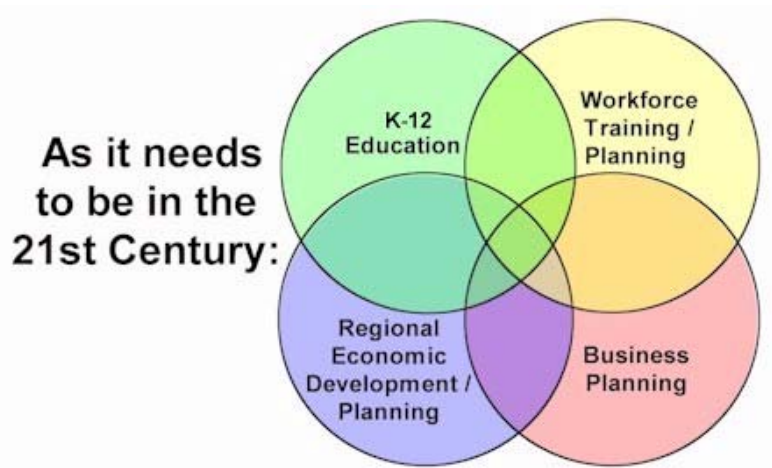


Figure 3. Networking and Information Flow As it Should Be for a Robust, Growing Regional Economy



The model illustrated in Figure 2 depicts the current networking structure among the business, economic development, workforce training, and education sectors. Business planning is a primary driver of workforce training and economic development because those two sectors try to capture and fulfill business needs to retain and attract jobs. Organizationally, the intersections among these three sectors occur in entities such as workforce development boards, economic development projects, chambers of commerce, and similar organizations. In most instances, these intersections are not robust until a region faces some sort of economic crisis or challenge. Within the current environment, K–12 education is a very minor player.

The critical role of brain power and workforce in the global economy suggest a much more active networking model. Transitions between school and work, and school and postsecondary education, become very important as the pace of change in the economy accelerates. Thus Figure 3 shows greater intersection of all sectors as a means of achieving competitive advantage in the New Economy.

Education has many other responsibilities than aiding economic development, and this report does not attempt to portray the full range of educational missions or the strategies needed for success across this spectrum of goals. However, all those other responsibilities are possible only if education succeeds in providing the foundation for a prosperous future. This does not mean that education for economic development is privileged more than other objectives. However, those who want education to succeed in resolving major concerns (e.g., equity, developing moral citizens, preparation for self-realization) need to incorporate perspectives about preparation for 21st century work into their planning.

Constructing a Framework for Economic Transformation

Quality of life, personal and national security, and economic development are the principal drivers for the agendas of most nations today. A 21st century education is the fundamental driver for achieving these interrelated goals. This report presents ideas about how America can achieve a quality K–12 education that prepares today’s children for tomorrow’s world.

Before framing the transformational steps, a guiding principle must be stated: Constructive interactions between children and adults are critical. The innovations this report proposes are all directed to enhance how adults and children together learn and grow.

In fact, when 21st century learning strategies are functioning fully in K–12 settings, this will empower deeper and more high-quality human relationships among children and adults, in and out of school.

The work framed here will be extraordinarily challenging for many reasons, including the following:

- Leadership turnover, especially among education and policymakers
- Myopic views of the threats and opportunities offered by globalization
- Myopic views of future learning needs for an increasingly technological world
- Myopic views of the potential contained in regional collaborations
- Embedded inertia in traditional schooling practices and processes
- Extensive bureaucracy in conventional local government practices and processes
- Often superficial results from previous attempts to achieve real partnerships among business leaders, education decision makers, and policymakers
- Limited experience with sustainable, large-scale transformations
- Gaps in knowing what needs to be done to advance K–12 learning for the 21st century

The average tenure of urban superintendents is fewer than three years, so it should not be surprising that construction of sustainable partnerships among various segments of a region will take continuous energy and commitment from all parties, despite frequent political and ideological shifts. Neglect of these relationships among business, government, and education has allowed dialogue to lapse into dysfunctional talk about the shortcomings of K–12 education rather than constructive planning with K–12 leaders to provide 21st century learning to all children, in and out of school. Further, the propensity of individual school districts in a region to work in silos rather than collaboratively has only recently begun to abate, due to economic pressures on districts and numerous demands on the K–12 sector that current educational practices cannot satisfy.

The gulf between educators’ experiences and the business world has expanded. Businesses, to survive, are rapidly shifting away from 20th century practices to global practices that rely upon 21st century tools and techniques. These are largely unfamiliar to today’s teachers and

administrators. The use of ICT to increase productivity and to advance core processes in business has not yet taken root in K–12 education.

Acknowledging that the work ahead will be hard is the necessary first step in this journey. New structures are required to guide a transformation from current policies and practices to innovative models that can serve today's children well. Powerful partnerships built upon strong relationships are the key that can create a new sustainable strategy, an agenda that evolves public perceptions from education seen as an expense, to education seen as an investment. These powerful partnerships must have the following characteristics:

- Building on trust and collaboration among leaders from business and education, with the support and engagement of other community and policy leaders
- Embedding strategic development processes to move beyond tactical political and ideological cycles and fads
- Infusing new models into conventional schools
- Using effective research and development processes to guide transformation
- Recognizing that information and communication technologies are drivers, engines, catalysts, and enablers—vital to accelerate scalability
- Evolving next-generation curriculum standards that create capacity for expert thinking, complex communications, and analytical reasoning
- Building from the classroom as the unit of practice, with teachers being central to the design
- Developing new sets of metrics to inform progress at the classroom, school, community, and regional levels

This report presents a suggested framework and process to guide scalable, regional transformations that will result in today's students being well prepared for 21st century careers. The urgency to advance a forward-looking agenda should allay any anxiety felt about the complexity of the actions needed. Our society needs to move forward on multiple fronts concurrently and should resist complacency and inertia that will deter the progress.

Vision, Structure and Leadership to Align Education and Economic Development

Powerful partnerships are fundamental to constructing a sustainable transformation of K–12 learning at scale. The foundation of powerful partnerships includes relationships built upon trust among key leaders. An effective powerful partnership creates the capacity to transcend changes in leadership, especially in the education and government sectors.

Developing Inter-sector Organizational Structures

Key to the success of any venture is effective relationships among leaders whose decisions have substantial impact. To accomplish the work described in this report requires active participation and support from community, business, and education leaders. Failure to create and sustain a “can do” will to achieve shall result in regression and resignation with the refrain: “This too shall pass.”

Frequent turnover in leadership (e.g., election, resignation, retirement, relocation, termination) has destructive consequences. People soon believe that efforts to change are public relations efforts rather than true improvement efforts. Similarly, a propensity to work in silos (e.g., K–12 education, higher education, business, city government, county government, state government, private sector, public sector, community-based organizations, unions) often has led to mistrust and preservationist behaviors.

How can a region create effective, powerful relationships that can be sustained? There are many partial examples, but few illustrations that have the wide-reaching agenda necessary for creating 21st century learning. A vital component is the construction of inter-sector organizational structures. What steps can various stakeholders in education and economic development take to address the challenges and opportunities discussed in this report? Below are recommendations for what people in various roles can do to create and implement a 21st century agenda for educational improvement within the larger context of economic and social development.

Creating a Framework and Focus for Partnerships That Educate Stakeholders about Critical Regional and Global Competitiveness Issues

A key to bringing about sustainable change is creating a sense of urgency about the issues discussed in this paper. To do that, stakeholders in education and economic development need to develop a framework of critical issues and organizational approaches to those issues. Those issues should include the need for global competitiveness to support and grow the economy, the need to rethink the nature of work and the skills needed for that work in the 21st century, and the prospect for significant labor shortages in terms of absolute numbers and specific skill levels. Issues such as these will resonate with the self-interest of the business and government sectors.

Such a framework also should include possible organizational approaches to building partnerships that include the education community. Several recommendations that appear below (e.g., creating an Economic and Education 2025 [EE2025] Commission) are good approaches. Stakeholders must tap into existing and emerging New Economy networks to learn about key issues and to partner in solving those issues.

Bringing cross-functional leaders together is a key part of the New Economy. Technological advances, best business practices, the recruitment of management talent, and the raising of risk financing are all enabled by the networking of entrepreneurs, bankers, scientists, government policymakers, and educators. Effective networking in the New Economy involves the intentional intersection of all sectors that create and enhance economic growth and prosperity. A good example of this type of collaborative, cross-industry networking is the Wisconsin Technology Council (www.wisconsintechcouncil.com). Formed to advise the governor and legislature on science and technology matters, the council has about 40 members drawn from the entrepreneurial, science, and technology communities. This network includes representation from government, higher education, and the K–12 community. Information on economic development, scientific progress, and regional action to implement New Economy initiatives is shared openly and disseminated through the council’s activities.

The Wisconsin Technology Council provides a statewide framework for discussing issues critical to the economic growth of the state. Similar structures are needed in other places to involve K–12 school and to create the vision and context for change and progress in education.

Creating Economics and Education Commissions (EE2025)

An EE2025 Commission would constitute a standing working group of regional leaders who collectively develop, advocate, and implement inter-sector initiatives among business, government, and education, using a two-decade strategic time frame. Such a commission would conserve the drive for transformation through periods of political change, offering a consistent vision to guide evolution that transcends cycles in politics and ideology. The EE2025 Commission could create opportunities for nurturing and sustaining scalable economic, social, and educational development solutions, targeting the year 2025 as a strategic benchmark.

The EE2025 Commission would be constructed by key leaders from the business, education, and government sectors. The following are some ideas on an agenda that such a commission’s members might undertake from their respective areas of expertise.

Role of Business Executives and Local Chambers of Commerce

- Form a working group of leaders from the local business community who are willing to focus on education and economic development from a strategic perspective. Discuss the ideas, case studies, and supplementary resources presented in this report.
- Foster the development of similar groups of business leaders in other localities around the region, using networking organizations such as Chambers of Commerce.

- Create a region-wide team of representatives from these local business groups to advocate for the creation of an EE2025 Commission. Invite policymakers and education leaders to participate.
- Initiate a strategic planning process for the EE2025 Commission designed to transcend cyclic changes in politics and to include the type of overall education-, economic-, and social-development framework described at the start of this report.
- Engage in outreach to build widespread public input into and support for the EE2025 Commission Strategic Plan.

Role of Policymakers at the Local, State, and Federal Levels

- Form a bipartisan working group of influential policymakers at the local and state levels who are willing to focus on education and economic development from a strategic perspective. Include representatives from workforce development groups. Discuss the ideas, case studies, and supplementary resources presented in this report.
- Foster the development of similar groups of policy leaders in other areas around the region, using bipartisan political organizations as a networking resource.
- Create a bipartisan, region-wide team of representatives from these groups of policymakers to advocate for the creation of an EE2025 Commission. Invite business and education leaders to participate; engage the support of federal policymakers.
- Initiate a strategic planning process for the EE2025 Commission designed to transcend cyclic changes in politics and including the type of overall education-, economic-, and social-development framework described at the start of this report.
- Engage in outreach to build widespread public input into and support for the EE2025 Commission Strategic Plan.

Role of Education Leaders

- Form a working group of local education leaders willing to focus on education and economic development from a strategic perspective. Include representatives from among teachers, the teachers' union or professional organization, school principals, school district administrators, school boards, educational service agencies, and institutions of higher education. Discuss the ideas, case studies, and supplementary resources presented in this report.
- Foster the development of similar groups of education leaders in other localities around the region, using networking organizations such as professional organizations for educators.
- Create a region-wide team of representatives from these local education groups to advocate for the creation of an EE2025 Commission. Invite policymakers and business leaders to participate.
- Initiate a strategic planning process for the EE2025 Commission designed to transcend cyclic changes in politics and including the type of overall education-, economic-, and social-development framework described at the start of this report.

- Engage in outreach to build widespread public input into and support for the EE2025 Commission Strategic Plan.

Establishing Vital, EE2025-Sponsored Educational Initiatives

The EE2025 Commission would assume a pivotal role in regional planning and development, capitalizing on powerful new strategies emerging from the intersection of economic and educational development. Vital educational initiatives offering strategic long-term benefits would include the following:

- Preparing students for 21st century work and citizenship
- Helping teachers and principals prepare their students for 21st century work and citizenship
- Building a cadre of business, policy, and education leaders
- Creating a standards-based technology infrastructure
- Sponsoring research

(Additional details are provided in Appendix B of this report.)

Powerful partnerships are fundamental to building the capacity to construct a sustainable transformation of K–12 learning at scale. The foundation of powerful partnerships includes relationships built upon trust among key leaders. A properly constructed, powerful partnership also creates the capacity to transcend changes in leadership, especially in the education and government sectors.

An Example: The Milwaukee Partnership Academy

The Milwaukee Partnership Academy (MPA) was one of the most comprehensive inter-sector organizational structures that modeled the components envisioned for an EE2025. MPA was formed initially by strong commitments from the chancellor of the University of Wisconsin–Milwaukee and the superintendent of Milwaukee Public Schools (MPS). Soon, the president of the Metropolitan Milwaukee Association of Commerce, the executive director of the Milwaukee Teachers Education Association, the president of the Private Industry Council, and the president of Milwaukee Area Technical College were recruited to serve on the executive committee of MPA. Their mission targeted the academic development of children in Milwaukee and the creation of highly qualified teachers.

Leaders from MPA committed resources to assure that collectively their organizations were working together, intentionally and purposefully to advance learning across the community. The leaders also recruited others to MPA leadership roles, including Wisconsin’s superintendent of schools, Wisconsin’s lieutenant governor, Milwaukee’s mayor, representatives of Milwaukee-area foundations, other institutes of higher education, and community-based organizations. Together, the chancellor and superintendent provided the vision and energy to move the MPA agenda forward.

All segments of member organizations were available to address the lack of academic success for many children in Milwaukee. Several initiatives were established to support the goal of all children being at or above grade level in reading and mathematics. These initiatives were led by cross-functional teams from MPA member organizations. Implementations of major projects were launched at scale.

Three of these projects have major technology components. One is the Curriculum Design Assistant (CDA). This initiative was already under way in MPS, and its value to a broader community was recognized quickly by MPA. CDA is a Web-based tool that guides the creation of standards-based lessons and allows easy sharing of these work products with others.

The second component is the MPA Reports. Communicating accurate and current information about academic achievement has been cumbersome at best. The Web-based MPA Reports have three components. The MPA Student Report is prepared so the student's family is able to view current performance on high-stakes testing including a three-year trend line for measured areas. There are also recommendations about academic areas to target and recommendations about where extra help can be secured. The MPA Teacher Report provides teachers with a summarized view for their *current* class, thereby reducing the research time needed to profile their class and target student development. The MPA School Report provides summary performance information for school leaders that assists with planning. This was a major effort of MPA that drew on an existing data warehouse and related query tools. The initial implementation produced 54,000 reports less than a year after the concept was introduced.

The third component is the Professional Support Portal. This project initially was conceived to use Web-based tools to assist with the induction and retention of new teachers. Through planning and development, the real power of portal technologies surfaced, and the design work was done to maximize functionalities of this powerful technology-based concept (Holland, Dede, & Onarheim, in press). These initiatives are described in greater detail in other parts of this report.

This work of MPA was reported periodically. External audiences at national conferences were both intrigued and amazed at the levels of collaboration exhibited across MPA. In many cases, MPA work was celebrated by the governance bodies of MPA member organizations. However, at times, governance bodies were skeptical and reluctant to endorse MPA-sponsored projects.

The MPA model was well constructed and properly targeted for the broader needs of Milwaukee. Exploratory discussions were being held to formalize a linkage between MPA and MPS's National Technology Advisory Board. Including other school districts in southeastern Wisconsin also was considered, but deferred until sustainable momentum was established with MPS. Unfortunately, MPA lost considerable momentum when the project's champions both left within a year (retirement; relocation and promotion), but the game plan to advance student achievement in core subjects continues as designed three years later, and the Professional Support Portal is growing in functionality and use.

Establishing a Sustainable Vision

In regional economic planning, the most successful partnerships involve three sectors: business, government, and education. Two of the three, government and education, directly or indirectly are encumbered by political cycles. Business, while not entirely free of outside and internal politics, is better equipped to create and sustain pressure on the other two sectors to move beyond cyclic changes in politics.

Where business is in a leadership or co-leadership position, the chances for sustained effort are improved. One only needs to look at how business organizes (e.g., trade associations, chambers of commerce) to see that these organizations have the ability to transition through periods of substantial political change.

Strategies and Strategic Plans—An Example

In the 1980s, Donna Shalala became chancellor of the University of Wisconsin–Madison. Under her leadership, the university established a strategic plan that transformed the nature and focus of research on the campus.

The old model of research consisted of a department model in which individual disciplines recruited faculty, encouraged discipline-based research, and sought funding to sustain a research program. The model had been very successful, but the nature of research in the 1980s was changing to an interdisciplinary model. The most important scientific and technological discoveries were happening at the intersections of disciplines, and thus entirely new areas of research were born, such as biochemistry.

A crucial problem was how to change the existing discipline-based research model into an interdisciplinary model that encouraged communication, planning, and research among the disciplines. A second problem was how to focus research efforts to achieve national prominence. This problem was solved by internal discussions that led to a decision to focus on research in the life sciences, ripe with emerging opportunities. This focus built on the strength of many life science programs in the university.

The first, and larger problem was how to get the attention of the departments and how to create incentives to change to an interdisciplinary model. The policy adopted was based on two powerful incentives: the competitive nature within university departments and the skills of the departments to seek greater budgets and more positions. Chancellor Shalala created a pool of positions by not filling vacant positions and reallocating a number of other positions. With a substantial pool of positions in hand (about 40), the university announced that these positions would be available through a competitive process in which slots would be awarded only to bids that involved two or more departments with joint interdisciplinary programs focused on the life sciences.

This strategy was repeated throughout multiple budget cycles. The results of the process were astounding, as university research grew at double-digit rates for more than a decade. University faculty created new ideas and technologies, such as the discovery and production of stem-cell lines that are used worldwide in research programs.

Building Effective Leaders

The importance of leadership style for engaging in transformation behavior cannot be overemphasized. The capacity to articulate a compelling vision, build trust, and empower followers to add value is discussed by Dede (2005, p. 128). Valdez (2004) describes further the behavioral cues associated with transformational leadership. All are consistent with the following discussion linking Collins' (2001) findings about successful business leaders to desirable attributes for education leaders.

The training of business, government, and education leaders for the 21st century is remarkably simple, yet frustrating in its complexities. Figure 2 on page 12 of this paper depicts the current *de facto* separation of educators from their business and governmental counterparts. Each of these entities is so focused on its internal issues and problems that its members tend to overlook how many solutions to their problems exist in other sectors of society. For example, businesses frequently complain that entry-level employees lack one or more of the skills they view as “givens” for high school or college graduates. However, only a relatively small number of businesses follow that observation with an articulated regional plan for addressing this problem through some constructive, reflective approach. Similarly, government often sees its primary role with business in terms of its oversight or regulatory function. Relatively few political leaders embrace the notion that governmental bodies at all levels have a major responsibility to create a rich and sustained business environment, including the development of a high-quality workforce in that region.

If an educator's first acquaintance with the business community is taking opposing sides on a bond referendum, clearly there has been inadequate discussion about the symbiotic relationship between effective schools and successful businesses. Neither schools of education nor schools of business teach their future leaders how to work together to create a strong, sustainable economy supported by a flow of highly qualified workers, managers and entrepreneurs. Theoretically, it should be a simple matter to incorporate these discussions into the curricula of both entities. That this does not routinely occur suggests leaders in the colleges of education and business do not see this symbiosis as critical to the future of the country.

Many countries have better articulation between business and education (e.g., Ireland, South Korea, and China). The role of government in these countries is explicitly to create “win/win” situations for all of the partners. The results are obvious and enviable. All three of these countries are enjoying impressive economic growth and becoming major “players” in the world.

Future leaders of American business, government, and education will have to think and act more like the leaders in emerging powerful economies. They will need to understand the interdependence of all of the partners in economically successful countries. In short, they will need to “own” the problems and the solutions together.

Government should encourage universities to develop programs that educate business and education leaders to understand the relationship between effective K–16 programs and powerful economies. Ideally, teams of educators and business leaders would develop models for working together as part of a larger effort to move to constructive, collective dialogue. This might be done in the context of coursework on “Taxes and Business” or “Corporations as Community Partners.” In any case, the sooner an enlightened dialogue can begin, the sooner comprehensive strategies can be developed and implemented.

More immediately, government should restructure a significant percentage of its resources to encourage functional partnerships among the business, education, and policy sectors at the local, state, and regional levels. Policymakers should create financial incentives that bring leaders to the planning table and that enable the development of comprehensive long-term strategies to promote economic growth.

Our society must reexamine historic demarcations between school and work. As the pace of change accelerates, so does the need for training and retraining. Which entity is responsible for periodic retraining may have more to do with who is best positioned to accomplish it than any traditional territorial notion. Workers may need to move into academic or technical training sites at regular intervals as methodologies change. Teachers in one context must become students in another.

The educational process must become facile, flexible, and ubiquitous. It also must be based on demonstrated, individual competence, as opposed to time in class or the age of the student. The term “grade level” must be a function of performance and competence, not time on task. Learning to read presents a similar challenge to an illiterate adult as it does to a first grader. For the first time in history, society is in a position to individualize instruction, create differentiated learning objectives, and measure success. Done properly, there is the potential to maximize each learner’s instructional experience.

The new leadership paradigm for business, education, and government must reflect the new economic realities we face in the United States. The countries currently cited as paragons of economic agility have much to teach our nation about what is required. These economies are focused on growth, not control. As such, they are more likely to be risk takers than caretakers. While they do not disdain the past, they embrace the credo that new problems and new realities will require new solutions. Creating innovative initiatives necessitates sustained cooperation among government, business, and education leaders. Officials who “own” too much of the past do not transition well into a successful future. Businesses more interested in the dress code than the genetic code are likely to be left behind in the scramble for economic health. Educational institutions focused on courses and credits may not have the capacity to teach and retrain in a timely, dynamic fashion.

A well-conceived and well-executed economic strategy requires leaders in all these sectors to have a common language and set of goals. This commonality suggests that leaders in all sectors must be able to understand and support their partners. It is no longer acceptable simply to “take care of your own business.” A booming economy cannot continue if the supply of well-educated workers disappears. Well-educated workers with no job prospects move out of regions that do

not offer them opportunity. In either of these scenarios, government suffers from a dislocation of its tax base and its economic engine.

What the new cross-trained leaders will have in common is broad vision for their region and a pervasive notion of statesmanship. Regional economic success requires a commitment to both the vision and the people who must actualize the vision. The leaders articulating a regional strategy must build widespread trust and respect that facilitates inter-sector work. As a region seeks to invigorate its economy, a moral or ethical commitment that respects the values and cultures of the various sectors is imperative.

Jim Collins (2001) comes closest to describing the kind of leadership required in his best selling treatise, *Good to Great: Why Some Companies Make the Leap ...and Others Don't*. He describes levels of leadership development, beginning with the “highly capable individual,” and moves through a hierarchy of skills and personal traits, ending with a description of the “Level 5 executive” (p. 20). According to Collins, “That person builds enduring greatness through a paradoxical blend of personal humility and professional will.” Collins takes great care in describing the attributes of the Level 5 leader as one who:

- Embodies a paradoxical mix of personal humility and professional will. This person is ambitious to be sure, but ambitious first and foremost for the company, not himself or herself.
- Sets up his or her successors for even greater success in the next generation, whereas egocentric Level 4 leaders often set up their successors for failure.
- Displays a compelling modesty and is self-effacing and understated. In contrast, two thirds of the comparison companies had leaders with gargantuan personal egos that contributed to the demise or continued mediocrity of the company.
- Is fanatically driven, infected with an incurable need to produce sustained results. He or she is resolved to do whatever it takes to make a company great, no matter how big or how hard the decisions.
- Displays workmanlike diligence—more plow horse than show horse.
- Looks out the window to attribute success to factors other than himself or herself. When things go poorly, however, Level 5 leaders look in the mirror and blame themselves, taking full responsibility. The comparison chief executive officers (CEOs) often did just the opposite—they looked in the mirror to take credit for success, but out the window to assign blame for disappointing results.

Two key questions arise from Collins’ analysis. First, how can this nation change its universities to educate more leaders with Level 5 potential? Second, how can this society develop an intentional strategy to evolve current decision makers in business, education, and government into Level 5 leaders? In short, how does this culture move its leaders away from gamesmanship and toward statesmanship? And how can this country transition from “looking out for No. 1” to building a regional consensus for the difficult work of sustained economic vitality?

Collins' work focuses on the leadership of great companies. The profile described above is also applicable to the kind of leadership required to design and drive a regional economic vision. Localities should identify companies in a region whose long-term success suggests the presence of Level 5 leadership and a culture of ingenuity. Bringing such individuals together would make an excellent starting point for mapping a comprehensive economic strategy that can survive changes in the political landscape and other types of adversity.

Every economic success story has champions with great vision and staying power. Clearly, any region desiring sustained economic health must begin with the right leadership, and building capacity for such leadership is crucial to success.

Enabling Learning for the 21st Century

While much is known about how to help students learn fundamental educational skills, this nation is having limited success at reaching all children. Powerful, proven models for transforming children's learning processes in and out of school and for enabling students' acquisition of 21st century skills and knowledge are largely lacking. More than ever before, today's children need to have learning experiences embedded in a context where the relevance of their studies to their future is apparent. It is difficult for children to dream about their future if their learning lacks a motivating, inspirational context. Too many children today are witnessing their parents on an economic treadmill, struggling to make ends meet and often working two or more jobs to provide for life's basic needs. These children are not seeing careers in their neighborhoods evolve toward global opportunities and 21st century skills, and many older youngsters in their community are having tremendous difficulty finding any employment, much less establishing meaningful careers. This is not a situation that builds dreams for the future in the minds of at-risk children.

Meeting Basic Needs for Our Children

There is a tacit but crucial assumption that successful students of the 21st century will have full command of their fundamental educational skills. That all students attain grade-level competence in reading, writing, and mathematics is foundational to all of the skills described as critical to economic and academic success. Indeed, none of the higher-order skills this report discusses can be accomplished by students whose intellectual functioning is mired significantly below grade level.

This issue is of particular importance in urban education in America. High percentages of urban children arrive in kindergarten without the requisite skills needed to succeed in school. Even with strong, directed pedagogy, these children must realize more than "year for year" gains in their mastery of the basics. There is a dismal pattern of falling further and further behind in most urban school districts. The lag in fundamental skills becomes a major factor as children are expected to move from mastery of the mechanics to application of the concepts. Reading for meaning or pleasure is a cruel hoax for a child with no word-attack skills. Most students who finally drop out of school are woefully below grade level and essentially unable to manage a high school curriculum.

Given the high levels of failure in urban school districts, an argument can be made that radical restructuring is required. While it is generally futile to hold children back, concentrating on their mastery of the basic skills is worthwhile. Technology can assist in several ways as educators develop new models of teaching and instructional management for students struggling with mastery. First, every child should be tested upon entry into public school. The testing should include a detailed identification of the student's beginning academic profile and should measure both strengths and weaknesses. This assessment can provide an initial guide to the educators responsible for the student's academic success. As the young student acquires the skills requisite to success, mapping his or her progress through further assessments is crucial. The progress a child makes or fails to make should be noted at regular, short intervals. Reteaching and shifts in strategy are critical to moving the child toward academic competence.

Obviously, this focus on individual analysis and progress requires a rethinking of how this country structures elementary schools. All of the adults in the child's life must assume ownership of a student's progress. The school and community must create ad hoc structures designed to focus on specific individual student needs. These ad hoc teaching structures should stay in place until the student gains mastery, without regard to lesser goals like "finishing" the curriculum.

Getting to this type of ad hoc environment requires an "all hands on deck" philosophy. One teacher with exclusive responsibility for 25–30 students cannot get the job done in urban schools, and large numbers of minority students will remain locked out of participation in the 21st century economy. In a world where the United States is at a major disadvantage in terms of human capacity, our society must learn to maximize the impact of our educational system on all of our citizens.

The Pivotal Role of Mathematics and Science Preparation

The Business Roundtable (2005) in its report, *Tapping America's Potential: The Education for Innovation*, states "Our goal is to double the number of science, technology, and engineering graduates with bachelor's degrees by 2015" (p. 1)

Citations supporting this goal include the following:

- Increasing international competition
- Increasing reliance on and reduced availability of foreign talent to work in the United States
- Alarming domestic trends:
 - The number of engineering degrees awarded in the United States is down 20 percent from the peak year of 1985.
 - Although U.S. fourth graders score well against international competition, they fall near the bottom or dead last by 12th grade in mathematics and science, respectively.

The research supporting this goal is thorough and well considered. This is a shared problem whose owners should include parents, educators (PK–16), business leaders, elected officials (e.g., local, state, national), and ultimately the children (Committee for Economic Development, 2003). There is no Sputnik-like event catalyzing these constituencies to collaborate in meeting the challenges outlined by the Business Roundtable.

Mathematics and science are the disciplines that form the building blocks for developing future engineers. The Minnesota High Technology Council (MHTC) provides an example of the collaboration required to mobilize a region at scale to reverse this trend.

An Example: Minnesota High Technology Council (MHTC)

MHTC, a private nonprofit group formed in 1982 and continuing until 1998, had as its goal to make Minnesota the best state in the nation for technology-based industry. MHTC determined that a well-educated and technically skilled workforce was its highest priority. That goal required that the state become highly involved in improving higher and K–12 education if the desired workforce was to be a reality. MHTC lobbied the legislature for programs that improved mathematics, science, and technology preparation.

MHTC determined that one of its most important activities was to encourage seventh- and eighth-grade students to become better prepared to take advanced mathematics and science offerings. One of MHTC's efforts was to develop an attractive brochure sent to the parents of each student entering those grades, detailing how failure by their children to take courses, especially algebra and physical science, would limit their career opportunities. This brochure noted that not taking such courses in those grades would prevent students from taking the mathematics and science sequences in high school, thus barring them from later qualifying for numerous careers that required high school courses such as calculus and physics. With the help of major newspapers, television, and radio stations, MHTC was able to create and support numerous regional meetings. At those meetings, parents and students were able to discuss the importance of seventh- and eight-grade students taking necessary foundation courses with the CEOs of major Minnesota employers, such as CRAY, 3M, Honeywell, Plato, Medtronic, and hundreds of other major corporations.

However, one must note that no current organizational entity is carrying forward the initiatives championed by MHTC. The Partnership for 21st Century Skills offers a credible framework for planning and development, but traditional mechanisms for advancing programs like P21 move at a glacial pace. Further, participating organizations often are distracted by the latest fad or political or leadership shift. Once again, this leads to the conclusion that new, sustainable, bi-partisan structures are needed to enable resetting priorities and optimizing the potential educational benefits emerging from ICT.

Setting Next-Generation Standards for Learning

The United States has benefited greatly from being the global innovation leader in the development and use of advanced technologies, but erosion of this leadership is now a major threat. The United States is not developing its workforce with skills in expert thinking and complex communications to meet the needs of the 21st century, global, knowledge-based economy (Levy & Murnane, 2004). Nor is the nation making strategic human-capacity investments to develop a nation of workers and citizens fluent in the use of advanced technologies. Prompt, broad-scale action to address this emerging crisis is imperative.

Vignette for Ida Assafa by Spence Korte

By the time I was 18, my senior class took the “trip of a lifetime.” We traveled 160 miles from New Jersey to Washington, D.C., and stayed for three days. The year was 1961. By contrast, a

young lady my wife and I had the pleasure to mentor for many years is having different travel experiences:

At 12, she completed her first trip to Ethiopia to visit family. At 14, she spent a week in Toronto with her school choir. A year later, she returned to Ethiopia for another visit. During her 16th summer, she traveled to Costa Rica to build homes for poor people. She spent three weeks building and traveling in that country. During her senior year of high school (2003–04), she lived with a French family for two weeks to round out her mastery of French. Instead of returning to Wisconsin after her first year of college, she traveled to Hong Kong to work with Chinese university students developing leadership programs for promising high school students. During the second part of her summer, she and the Chinese university students returned to her American university to design a complementary program for American high school students. Clearly, my mentee already has had a richer global experience than most of my contemporaries and I had at the same age.

While Ida is not typical of all children today, she does have many of the attributes of the “millennial” child growing up with the Internet and mobile wireless devices as fundamental parts of their world. What are we as educators doing in our classrooms and communities today to help children prepare for their global world? Advanced information and communications technologies are catalysts for these transformations.

How might a K–12 education system that is responsive to our changing world look in practice? Imagine being a high school student in 2025. A process with which most people are familiar is subject selection, and it is reasonable to assume that in 2025 students will still have periodic counseling sessions with an educational advisor. The following scenario describes the experience for Charles Wright.

Vignette for Charles Wright

Having turned 16 last month, Charles Wright is enrolled in Washington High School. He is about two thirds complete with his certifications for high school and has begun entry-level experiences with a specialization. Charles also has accumulated 1.3 years in his IHE.vest account (see page 31) and just has completed subject selection for his next learning cycle. The offerings he selected—with considerable input from his teachers, his counselor, his business advisor, and his parents—include the following:

- **Technical Writing.** *This course is offered in a traditional classroom setting and emphasizes professional report writing, correct grammar and syntax, and technical vocabulary. Certification will be awarded when the student has prepared three reports judged successful by a panel of managers from the community. Prerequisite: Certification at Level 4 writing*
- **Applied Algebra II.** *This course is offered in a traditional classroom setting and features applications of mathematics in problem-based settings. The instruction emphasizes working with very small numbers and judging reasonableness of conclusions. Certification will be awarded when the student has successfully achieved proficiency in*

five units of instruction. Students also will be expected to complete online skill development units. Prerequisite: Certification at Level 2 mathematics

- ***Spanish IV.*** *This course emphasizes conversational Spanish and is presented four days per week (Monday–Thursday) via interactive video by instructors from Mexico (Weeks 1–4), Puerto Rico (Weeks 5–8), Colombia (Weeks 9–12), and Catalonia (Weeks 13–16). It will feature the cultures of each of these locations. Certification will be awarded when a student achieves Level 4 proficiency as judged by the review panel. Times for performance reviews can be scheduled on Fridays. Prerequisite: Certification in Spanish III and sponsorship by a local teacher-advisor*
- ***Pacific Rim Governments.*** *This seminar is offered to students from nations around the world. There are five topical seminars offered via interactive video as synchronous events. Time zone considerations will require interaction during late night or early morning. Local universities offer access for the rare students who do not have interactive video available at home. Participants also will engage in online, internationally brokered, asynchronous discussions. Students will be awarded certification upon successful completion of papers juried by peers and a representative of their nation’s state department. Prerequisite: Sponsorship by a local teacher-advisor*
- ***Life Sports III.*** *This course is taken two evenings per week (Tuesday and Thursday) and Saturday morning and is offered by the local YMCA. The emphasis is on conditioning and gymnastics, and participants interact as a multiage (12–19) group. Certification will be awarded to students who: (1) engage continuously for 15 weeks and (2) demonstrate proficiency in two skills. Students who successfully complete Life Sports III will be eligible to apply for employment as a coach for the YMCA’s Gymnastics Club (ages 4–7). Prerequisite: None*
- ***Freshwater Ecologies Coop*** *[this is a continuing course from the prior cycle]. This course is offered three afternoons per week (Tuesday, Wednesday, and Thursday) in conjunction with an internship (Monday–Friday) at the local water treatment plant and is copresented by a manager and a professor from the Great Lakes Program at the local university. There is an articulation agreement with the local college for dual certification. Course certification will be awarded based on review of lab performance and successful completion of two research reports. Internship performance will be based on the same criteria used to review entry-level employees at the water treatment plant. Prerequisite: Enrollment in Environmental Studies specialization.*

Let’s take this scenario from the top:

- Too often, today, our nation is losing our students because they are unable to recognize a connection between their formal learning experiences and future opportunities. This “specialization” enables Charles to develop a concentration of studies in an area of interest. The specialization has evolved from a series of intentionally created experiences (beginning in elementary school) that help him identify his strengths and interests; information that is embedded in his personalized student profile. Charles is not “locked” into this specialization, and in many cases there are related pathways he can pursue should he discover his interests are shifting as his knowledge expands.

- In 2010, some courageous people began a student development program that made investments in postsecondary student learning accounts. This “IHE.vest” program provides a scaled set of rewards for all students for accomplishments. Some of the smaller investments are offered to reward appropriate behaviors such as good attendance, punctuality, and citizenship. Other, larger investments are offered to encourage students to pursue specializations in areas considered of high need. Students and their family may monitor the growth of their personal IHE.vest account. The genesis for this program was modeled, in part, on the GI Bill, a program available to military personnel during the last half of the 1900s.
- The technical writing course reflects the importance of achievement more than “seat time.” It also bridges the business and education communities, benefiting children, educators, and business personnel. Technology readily eases the unnecessary and disruptive burden of frequent face-to-face meetings. Certainly, the “readers” should be included in the celebration of student’s completion, an experience in which everyone is a winner.
- Not all learning in mathematics needs to be done with the direct support of a teacher. Practicing routine skills is done more efficiently and effectively in an online environment. However, helping students grasp core concepts, personalizing learning, and providing examples centered on applications of mathematics in the real world continues to require the leadership of a skilled teacher.
- A special teacher certification has evolved during the last 15 years. This certification recognizes the special skills developed to support learning in distributed environments. The Spanish content, in this case, appropriately draws upon native speakers and equips students to function effectively in second-language environments. The far-end locations provide students with enriched learning experiences that reach well beyond their local neighborhood. If the world is going global, it might serve our children well to enable them to learn what this means at every opportunity.
- What better way for children to learn about the function of governments than to have “classroom” experiences that engage students in real applications of government with government workers? What better way to learn about the impact of time zones for a global workforce than to simulate that environment within a meaningful learning experience? And what better way for children to begin to understand about postsecondary education opportunities than to give them an opportunity for carefully constructed on-campus experiences?
- Schools recognize the need to encourage students to learn the value of an active lifestyle. However, due to limited resources, communities expanded functions for schools in their communities and in some cases eliminated duplication. For example, branch libraries are now located within schools. Community centers also have been combined with schools. In this case a local service provider, the YMCA, contracts for the use of school facilities during nonpeak hours. This also makes access for neighborhood residents more convenient and has built community support for improved school facilities.

- An intentional partnership that includes local schools, colleges, and regional government creates high-quality, high-need learning experiences for students. Once again, Charles gains exposure to postsecondary learning, and he also acquires real-world employment experiences that will serve him well in a workplace with few safety nets.

While this may appear futuristic, the foundational elements are in place to implement this scenario today. Let's explore components that will be in play.

Implementing 21st Century Curricula, Pedagogies, and Assessments

As far back as the early 1990s, reports have identified higher-order thinking skills as key for 21st century work. These reports were developed by distinguished, appointed commissions that included economists, business representatives, educators, and policymakers. Examples of early documents that incorporate 21st century skills still central in current reports on this topic include The Secretary's Commission on Achieving Necessary Skills (1991) report, *What Work Requires of Schools: A SCANS report for America 2000*, and the National Center on Education and the Economy's (NCEE) (1990) report, *America's Choice: High Skills or Low Wages*. This demonstrates that these skills are not some current "fad" and that generic 21st century skills are stable despite the massive economic shifts that have occurred in the past 15 years. What resources today can educators use to understand what is involved in preparing students for life in the global, knowledge-based economy characteristic of 21st century civilization?

The Partnership for 21st Century Skills (P21) is the latest in a series of business-education groups that have delineated generic, core content and cognitive, affective, and social processes important in the 21st century workplace. In recent years, P21 (www.21stcenturyskills.org) has emerged as a leading advocacy organization focused on infusing 21st century skills into education (Partnership for 21st Century Skills, 2005). This group brings together the business community, education leaders, and policymakers to define a vision for 21st century education that can aid every child's success as citizens and workers in the 21st century.

Since its inception in 2002, the P21 has introduced a set of comprehensive tools to help education stakeholders integrate 21st century skills into learning:

- *Learning for the 21st Century: A Report and MILE Guide for 21st Century Skills* articulates a collective vision for learning in the 21st century and provides a self-assessment tool that assists schools, districts, and states in determining their progress in defining, teaching, and assessing 21st century skills.
- *Route 21: An Interactive Guide to 21st Century Learning* is a Web-based tool that assists education stakeholders in supporting and promoting achievement of ICT literacy and 21st century skills. As a result, users can develop and implement a plan to support a successful 21st century learning environment.
- *The Road to 21st century Learning: A Policymakers' Guide to 21st Century Skills* assists state education leaders in crafting visionary education policies. The report offers specific guidance and policy recommendations to help create a 21st century learning environment.

- *ICT Literacy Maps* are a series of matrices that illustrate the intersection between ICT literacy and core academic subjects including geography, mathematics, English, and science. The maps enable educators to gain concrete examples of how ICT literacy can be integrated into core subjects.
- *The Assessment of 21st Century Skills: The Current Landscape* offers the current landscape of educational assessments that support 21st century learning. An associated online tool, *Assess 21*, is a Web-based repository for information on assessments of 21st century skills.

These reports and tools document that what society needs in order to educate all children well so they can reach their full potential in 21st century work, citizenship, and life is a curriculum centered on interrelated core knowledge and skills taught via guided inquiry and collaborative learning.

The perspective P21 takes is consistent with that of many economists and of nonprofit organizations that address workforce-capacity issues (such as the NCEE). For example, Levy and Murnane (2004) identify expert thinking and complex communication as core higher-order skills for the 21st century workplace. They describe the impact of current, standards-based approaches on the teaching of these skills, depicting an exemplary response by a public school in Massachusetts but also discussing many other educational settings in which standards-based reform has not advanced—has perhaps even impeded—students from learning expert thinking and complex communications. Many educators, including the authors of this report, feel that first-generation models of standards-based curricula, high-stakes tests, and accountability policies are deeply flawed from the perspective of preparing students for 21st century work and citizenship.

Challenges to Implementing 21st Century Curricula, Pedagogy, and Assessments

In contrast to what economists, business representatives, and educators agree are the higher-order knowledge and skills necessary for the 21st century, the current model of education improvement is the federal No Child Left Behind (NCLB) Act, supported by both major political parties and the general public and based on “test-to-standard” strategies (Dede, 2005a). Currently, content standards are developed by disciplinary experts, and high-stakes tests then document whether or not students are learning the content. Individual students, teachers, schools, and districts are rewarded or punished based solely on test performance. Even though the concept of standards, assessments, and accountability makes sense at a fundamental level, the initial version of this approach to improving educational achievement has many problems from the perspective of preparing today’s children for tomorrow’s world.

The current content standards are based on disciplinary “silos.” For example, physics experts indicate what precollege students need to know if they eventually plan to be physicists; historians determine what pupils must master if they are to become professional historians, and so on. Therefore, experts will decide what students need to learn to pass a high-stakes test or in order to prepare for college. This has led to a huge tangle of content that U.S. educators are mandated to cover in just 12 years—an impossible task! Much of what is taught within a subject is only useful to the small subset of students who plan to focus on that particular field in college. These

disciplinary standards are not interrelated or prioritized to emphasize core knowledge *all* of our students will need to succeed in the 21st century.

Teachers are using strategies such as lecture and drill-and-practice to race through the glut of recipes, facts, and test-taking skills they are expected to cover. Despite research indicating that guided inquiry, collaborative learning, mentoring, and apprenticeships are far more effective instructional strategies, teachers feel they just do not have time. They know that using these methods takes up too many class periods, compared with simply delivering information for students' passive absorption. Sadly what is left out is the teachers' means to prioritize knowledge and skills in terms of 21st century citizenship; workplace capabilities for the global, knowledge-based economy; and lifelong learning.

The first generation of high-stakes tests that our nation is using to determine students' educational outcomes has substantial flaws. These are summative, "drive-by" tests, which provide no just-in-time feedback that could help teachers aid struggling students. In addition, while some tests emphasize on core ideas and measure at least a few higher-order thinking skills, many state legislatures have allocated such limited resources for test development that the resulting instruments often measure only a random assortment of low-level skills and content rather than core, higher-order 21st century knowledge.

Many other criticisms are leveled at the weaknesses of first-generation curriculum standards, tests, and accountability measures. In addition, "solutions" such as financial incentives for teachers to raise test scores can exacerbate already troubling differences in educational outcomes, promoting abandoning the very at-risk students the NCLB legislation was intended to help. Yet this reform movement has strong bipartisan support politically and widespread backing from the public. Under these conditions, what can educators do to prepare students for 21st century work and citizenship?

Tactics and Strategies for Enabling 21st Century Education

In the long run, the nation's best strategy under these circumstances is an evolution to second-generation curriculum standards, pedagogies, and assessments. Society must develop ways to restructure the current "mile-wide, inch-deep" curriculum into engaging, interrelated core knowledge and skills. Through design-based research, scholars must create scalable, sustainable instructional models based on active, collaborative learning. Researchers must develop evaluation methods that complement high-stakes tests with formative, diagnostic student assessment interwoven into teaching and learning. However, delineating all the strategic initiatives necessary for moving to second-generation reform is well beyond the scope of this report. The sections below instead describe tactical steps educators can take "tomorrow morning" to foster 21st century knowledge and skills in the era of NCLB, then sketch some initial, strategic investments foundational for transformative evolution of the nation's current approach to improving schools.

Exemplars of Initiatives Based on P21

A number of groups are implementing ideas and tools from P21. Their work provides exemplary illustrations of how educators can proceed with preparing today's students for tomorrow's world:

- North Carolina has initiated the first-ever 21st Century Skills Center to help students acquire the knowledge and skills needed for success in the global economy. The center is focused on better preparing students for the high-skilled jobs of the new economy by redesigning PK–14 curriculum, updating educator training and providing improved student assessments in North Carolina. The center will collaborate with K–12 school systems, community colleges, and teacher education institutions in the state to develop and pilot its programs (P21 News Report, 4/21/2005).
- Napa, California's New Technology High School is integrating ICT throughout the educational process. The high school's curriculum reflects this 21st century approach to education. Students take courses in traditional core subjects and can select courses in business ventures, digital media, computer-assisted design, global studies, imaging, leadership, and TV/video (Road to 21st Century Learning, pp. 10–11).
- Community Consolidated School District 15, a 12,390-student, K–8 district in suburban Chicago, made comprehensive changes to its system to achieve measurable results, which exemplify the use of 21st century tools and contexts to improve student achievement in core subjects (Road to 21st Century Learning, pp. 12–13).
- The Metropolitan School District of Lawrence, Indiana, has a Digital Literacy initiative that focuses on strong reading, writing, and thinking skills. To achieve this knowledge, students are taught to use a variety of technologies in a proficient way and exhibit the inventive thinking sought after in a global economy (Ken Kay to the CCSSO, 2005).
- The Cisco Networking Academy Program is a comprehensive e-learning program that provides students with the Internet technology skills essential in a global economy. The Networking Academy delivers Web-based content, online assessment, student performance tracking, hands-on labs, instructor training and support, and preparation for industry standard certifications. Launched in October 1997 with 64 educational institutions in seven states, the Networking Academy has spread to more than 150 countries. Since its inception, more than 1.6 million students have enrolled at more than 10,000 academies located in high schools, technical schools, colleges, universities, and community-based organizations.

But how do today's students respond to these educational initiatives based on learning tomorrow's skills?

Building on Students' Neomillennial Learning Styles

Rapid advances in information technology are reshaping the learning styles of many students (Dede, 2005b). A variety of authors discuss the influence of media such as the World Wide Web on students' learning styles (Howe & Strauss, 2000; Oblinger, 2003; Tapscott, 1998). For example, by its nature, the Web rewards comparing multiple sources of information, individually

incomplete and collectively inconsistent. This induces learning based on seeking, sieving, and synthesizing rather than on assimilating a single “validated” source of knowledge as from books, television, or a professor lecturing.

Also, digital media and interfaces encourage multitasking: Many teenagers now do their homework by simultaneously skimming the textbook, listening to a MP3 music player, receiving and sending e-mail, utilizing a Web browser, and conversing with classmates via instant messaging. Whether multitasking results in a superficial, easily distracted style of gaining information or a sophisticated form of synthesizing new insights depends on the ways in which this learning strategy is used. Certainly, at some number of simultaneous tasks, this strategy results in cognitive overload and concomitant loss of effectiveness.

Overall, the Internet-based learning styles ascribed to “millennial” students born after 1982 are increasingly true for many people across a wide range of ages, driven by the tools and media they use every day. In addition, as computers and telecommunications continue to evolve, new forms of “neomillennial” learning styles are emerging. In the next decade, three complementary interfaces to information technology will shape how people learn (Dede, 2002):

- The familiar “world-to-the-desktop” interface, providing access to distant experts and archives, enabling collaborations, mentoring relationships, and virtual communities-of-practice. This interface is evolving through initiatives such as Internet2.
- “Alice-in-Wonderland” multiuser virtual environments (MUVE) interfaces, in which participants’ avatars interact with computer-based agents and digital artifacts in virtual contexts. The initial stages of studies on shared virtual environments are characterized by advances in Internet games and work in virtual reality.
- Interfaces for “ubiquitous computing,” in which mobile wireless devices infuse virtual resources as people move through the real world. The early stages of “augmented reality” interfaces are characterized by research on the role of “smart objects” and “intelligent contexts” in learning and doing.

The “millennial” learning styles discussed stem primarily from the world-to-the-desktop interface; however, the growing prevalence of interfaces to virtual environments and augmented realities is beginning to foster “neomillennial” learning styles. The crucial factor leading to the augmentation of “millennial” learning styles with “neomillennial” characteristics is that the “world-to-the-desktop” interface is not psychologically immersive, while in contrast virtual environments and augmented realities induce a strong sense of virtual “presence.”

Most students now using MUVEs do so in the context of gaming. While the content of these games and activities often does not lead to knowledge useful in the real world, with good design rich types of learning and identity formation can take place in these environments, fostering “neomillennial” learning styles based on characteristics of immersive mediated interaction. Dede’s research on MUVEs crafted for educating young people about higher-order inquiry skills illustrates this. With National Science Foundation funding, he and his colleagues are creating and studying graphical MUVEs that use digitized museum resources to enhance middle school students’ motivation and learning about science and society

(muve.gse.harvard.edu/muvees2003/). Their goal is to promote learning for all students, particularly those unengaged or low-performing.

The “River City” MUVE is centered on skills of hypothesis formation and experimental design as well as on content related to national standards and assessments in biology and ecology. This research demonstrates how students can gain this knowledge through immersive simulations, interactive virtual museum exhibits, and “participatory” historical situations (Nelson, Ketelhut, Clarke, Bowman, & Dede, 2005). Students learn to behave as scientists while they collaboratively identify problems through observation and inference, form and test hypotheses, and deduce evidence-based conclusions about underlying causes.

Dede’s group is now conducting large-scale studies to assess the strengths and limits of this educational approach, in particular how MUVEs shape students’ learning styles (Dede, Nelson, Ketelhut, Clarke, & Bowman, 2004). Other researchers who study educational MUVEs designed for young people, such as Quest Atlantis (atlantis.crlt.indiana.edu/start/index.html) and Whyville (www.whyville.net), also are assessing how immersive virtual environments influence their participants’ learning styles (Barab, Thomas, Dodge, Carteaux, & Tuzun, in press; Dede & Palombo, 2004).

As an illustration of ubiquitous computing for learning, Klopfer and his colleagues are developing augmented reality (AR) handheld computer simulations that embed students inside lifelike problem-solving situations to help them understand complex scientific and social dynamics (education.mit.edu/ar/). Participants in these distributed simulations use location-aware handheld computers (with Global Positioning Systems technology), allowing users to physically move throughout a real-world location while collecting place-dependent simulated field data, interviewing virtual characters, and collaboratively investigating simulated scenarios. For example, their “Environmental Detectives” AR simulation engages high school and university students in a real-world environmental consulting scenario not possible to implement in a classroom setting (Klopfer & Squire, in press). Students role-play environmental scientists investigating a rash of health concerns on the MIT campus linked to the release of toxins in the water supply.

What “neomillennial” learning styles might these media-based lifestyle shifts induce? Research on educational MUVEs and ARs suggests that the following may emerge as cross-age learning styles (Dede, 2005b):

- Fluency in multiple media, valuing each for the types of communication, activities, experiences, and expressions it empowers (Dede, Whitehouse, & Brown-L’Bahy, 2002). This goes beyond “millennial” learning styles, which center on working within a single medium best suited to one’s style and preferences.
- Learning based on collectively seeking, sieving, and synthesizing experiences rather than individually locating and absorbing information from some single best source. This goes beyond “millennial” learning styles in preferring communal learning in diverse, tacit, situated experiences more than solo integration of divergent, explicit information sources and in valuing knowledge distributed across a community and a context as well as within an individual.

- Active learning based on experience (real and simulated) that includes frequent opportunities for reflection. This goes beyond “millennial” learning styles in valuing bicentric, immersive frames of reference that begin with direct participation and then infuse guidance.
- Expression through nonlinear, associational webs of representations rather than linear “stories” (e.g., authoring a simulation and a Web page to express understanding, rather than a paper). This goes beyond “millennial” learning styles in using representations involving richly associated, situated simulations rather than branching but largely hierarchical multimedia.
- Codesign of learning experiences personalized to individual needs and preferences. This goes beyond “millennial” learning styles, which emphasize selecting a precustomized variant from a range of services offered.

Mediated immersion likely has other influences on learning style yet to be discovered, but these initial findings have a variety of implications for how students can acquire 21st century knowledge and skills through pedagogies and media that engage their interests, build on strengths from their leisure activities outside of school, and speak to their learning styles.

Making Strategic Investments in Educational Research

Sketching all the types of strategic initiatives necessary for developing second-generation standards-based education reform is beyond the scope of this report. Research is foundational to such a transformative evolution of education policy; and intersector organizational structures among business, government, and education can plan a vital role in increased funding for certain types of education research (Dede, 2001). This is vital to ensure that school reform initiatives are reflective, ongoing processes of continuing improvement rather than occasional spasms of discontinuous and unsustainable change. Federal, philanthropic, and business funding both for research centers and for competitive grants to individual projects is essential to provide a diverse “ecology of innovation” from which the best strategies for educational improvement emerge.

Donald Stokes’ book, *Pasteur’s Quadrant: Basic Science and Technological Innovation* (1997), presents a compelling case for organizing research efforts in a manner that links basic research to the solution of practical problems of concern to society. The book’s title and its central thesis were inspired by the work of Louis Pasteur, the French microbiologist who made a series of major theoretical breakthroughs by analyzing the causes and solutions of applied problems faced by farming and industry. Stokes argues that society should fund primarily “use-driven” basic research—as opposed both to “pure” curiosity-driven basic research or to applied research absent a conceptual framework (e.g., Thomas Edison’s work)—and presents numerous examples and suggestions to support his strategy. Use-driven research in education is dramatically underfunded by our society.

A related type of research also underfunded is sizable implementation “test beds” that study issues of scalability, generalizability, local adaptation, and sustainability. Integrating current research on important pieces of the educational puzzle into next generation, overarching models of innovation is a task that calls for different funding scales and mechanisms than typical today.

Even when projects strive for greater descriptive understanding of educational and societal dynamics, their emphasis is generally on laboratory or design experiment studies that create atypical “islands of innovation.” However, despite the fact that practitioners and policymakers are focused on exactly these issues, funding for such test beds is currently only a minute fraction of the already small educational research portfolio.

Research centers targeted to particular sets of practical problems in education and charged with developing and evaluating learning technologies that aid those problems are a means of supporting such test-bed studies. Building capacity in the educational research community is also an important issue. Improving the preparation and professional development of educational researchers to reflect the perspectives above is vital for producing a sufficient number of skilled investigators to conduct these types of studies. Reconceptualizing research priorities and processes to focus more on implementation studies mutually developed by scholars, practitioners, and policymakers is a promising strategy to develop sustainable impacts on practice.

Research centers with these types of objectives and methods are just beginning to form. In 2004, the National Science Foundation funded the Pittsburgh Science of Learning Center (www.learnlab.org). This center provides LearnLab, a research facility designed to dramatically increase the ease and speed with which learning researchers can create the rigorous, theory-based experiments that pave the way to an understanding of robust learning. LearnLab makes use of advanced technologies to facilitate the design of experiments that combine the realism of classroom field studies and the rigor of controlled theory-based laboratory studies.

An example even closer to the business, government, and education partnerships advocated in this report is the Friday Institute at North Carolina State University (www.ncsu.edu/friday/). The Friday Institute was jointly created by business, university, and government in North Carolina. The Institute engages 21st century demands with its mission to advance education through innovation in teaching, learning, and leadership. By focusing on research and innovation of sophisticated learning technologies for educational settings, the Friday Institute generates and diffuses a wide range of powerful applications adaptable to effective usage across a spectrum of real-world contexts. To achieve this mission, the Institute has established three strategic goals:

1. To research, develop and disseminate K-20 educational solutions that meet 21st century demands.
2. To generate and propagate effective technologies for teaching and learning.
3. To strengthen educational capabilities of rural and underserved communities in North Carolina and beyond.

As the Friday Institute illustrates, intersector organizational structures among business, government, and education for scalable, linked economic and educational development can play an important role in advocating for and funding these types of educational research.

Leveraging Data, Policies and Practices

Application of Data-Based Decision Making

Two factors are having a dramatic impact on the practice of teaching: accountability and technology. To consider them in isolation from each other is nearly impossible. Technology enables access to extraordinarily robust sets of data. The push for accountability at the local, state, and national levels is “opening the door” to each teacher’s classroom. Vendors are developing management systems to monitor the academic progress of each child in smaller, more discreet segments. These systems are linking individual students’ performance to their teacher’s instructional practices and curriculum resources, as well as to school leadership and culture.

Businesses routinely have been using sophisticated data-based decision making (DBDM) tools in every major business segment, from communications to healthcare to manufacturing to retail. Wal-Mart, for example, analyzes customer purchase habits to more effectively position products for customer convenience, such as putting paper towels on shelves adjacent to window cleaner. Amazon.com analyzes buyer habits and offers “suggestions” tailored to their customer’s preferences. Very robust tools have been developed to facilitate these analysis processes. The analysis tools are industry-proven, but are not necessarily business specific.

While the track record for use of DBDM tools in business is proven and relatively long, the use of DBDM tools in K–12 education is comparatively primitive and recent. Educators are only at the early stages of understanding what information will inform learning, and similarly at the early stages of understanding how to use the information for which they already have access. Using DBDM effectively is a sophisticated process, and this type of decision making is not effectively done in a casual, haphazard, or intermittent manner. However, research suggests that thoughtful, long-term use can result in substantial advances in student achievement (National Research Council, 2001).

Educators cannot engage in effective use of DBDM to support learning without an appropriate technological infrastructure. The foundation must be constructed carefully both to optimize efficiency and to facilitate easy usage. Reliability and accessibility are also important. Fortunately, industry-proven tools and methodologies for constructing a solid DBDM infrastructure are available to adapt to educational settings. The challenge for educators is creating the professional climate conducive to the use of DBDM to and then deciding and discovering what data informs learning.

Moody and Dede (2005) offer insight into the types of analysis that might take place in schools and conditions that increase effective application of DBDM:

Recent advances in technology allow school staffs to engage in a process of reflection and interpretation of data that previously was analyzed and interpreted for exclusively by outside officials or researchers. This movement of the power of interpretation from outside to inside enables schools to develop policies for internal accountability for increasing effectiveness by which they can build ownership of school improvement work.

The net result of moving ahead with DBDM is a much more public exposure of the work taking place in individual classrooms. Teachers can view the work of individual students from multiple perspectives, easily and longitudinally. Decision makers also can link the performance of students to their teachers for multiple school years.

Below are drafts of four vignettes depicting how future students, teachers, administrators, and policymakers might benefit from the more detailed information that next-generation assessments could provide. The intent of these images is to portray the potential of sophisticated assessments to enhance many types of educational decision making.

Student

Middle school student Marie LaSalle was in the middle of a group project to design a research station for scientists in Antarctica. She and her fellow students were in a reflective stage of their activities. They were designing scoring rubrics (e.g., what are we learning? what is quality work?) to judge the individual presentations that group members would do later that week on their complementary parts of the overall design.

Self-assessment was Marie's favorite part of the activity; it brought out her strengths in reflecting on patterns of thinking. She had realized this a few years ago when engaged in a science unit on force and motion. The curriculum included a structured way to assess skills related to the scientific process (e.g., hypothesizing, experimenting, collaborating). Until then, Marie had struggled in science, but that conceptual framework had helped her see the stages of cognitive, affective, and social skills involved. She had narrowed her focus to becoming the group expert on experimenting, building on a curriculum unit from the prior year on controlling variables. As a result, she became a leader in the team, valued for her insights.

Marie had become much happier in school as she better understood her own thought processes. Her ideas took time to develop, evolving at almost a subconscious level, then suddenly materializing. She had learned to be comfortable while other students chattered and seemed to move far ahead, knowing that her eventual insights would provide a valuable perspective. Her teacher had helped her see this was a facet of her overall learning style, consistent with the ways she was a leader in the asynchronous discussion forum outside of class time, which provided lots of time for reflection. Without this type of metacognitive insight about her strengths, Marie knew she likely would have lost confidence in her abilities and given up on learning.

Teacher

Second-grade teacher Bruce Wayne sat at his desk, planning the next week of mathematics lessons. On his computer screen was a three-dimensional representation of how children understand arithmetic word problems involving addition or subtraction. The learning trajectories through this space for each student in his class were visible; about two thirds of his students were at a similar stage of understanding. Bruce was thinking about what supplementary activities he could use to help the other third who were at a range of levels from far behind to considerably ahead of the central group.

Shantha, for example, seemed interested in mathematics but was struggling to learn English (her parents had recently emigrated). Linguistic challenges made word problems difficult for her, so using mathematical manipulatives to convey the underlying arithmetic skills was crucial to keep her from falling further behind and also losing motivation. Bruce brought up a cognitive trace of her work from the intelligent tutoring system for subtraction. This helped him understand the “bugs” in her current problem-solving strategies.

Involving Shantha’s parents in her mathematical development was crucial since Bruce had limited time for individualized instruction given the large number of students in his class. He planned to meet with them later this week and demonstrate how they could help Shantha understand the textual responses of the intelligent tutoring system as she used this at home. However, her parents had indicated they felt her progress in arithmetic was fine, typical of what students achieved in their own country. Bruce planned to display the U.S. Developmental Assessment charts to demonstrate how Shantha’s understanding was falling behind similar students in this country on the continuum for arithmetic. Having such a sophisticated set of diagnostic resources and associated instructional interventions was a great relief to Bruce; a decade ago, all he could have done in a similar situation was show parents low test scores and suggest homework with drill-based worksheets.

Administrator

Dr. Martha Kent, superintendent of the Metropolis School District, was preparing for the school board meeting that evening. In addition to the usual business to be conducted, this month she planned to report on how well the district’s middle schools were achieving the curricular goals for science education. She knew her data would surprise many members of the community since the best performing middle school in enhancing educational outcomes was in a less affluent part of the city and had lower state test scores in science than its counterparts in wealthier regions of the district. In earlier times, a school with test scores below the districtwide average would have been labeled “underperforming” and forced to change its curricula and pedagogy to match that of schools with higher scores. More sophisticated assessments now enabled a richer, more accurate picture of student attainments and curricular interventions.

Data aggregated from teachers’ classroom assessments and students’ activity patterns showed an intriguing situation. In the high-performing middle school, students evidently were excited by an innovative inquiry-centered science curriculum in place for the last three years. Fewer pupils were avoiding optional offerings in science and mathematics, and more were enrolling in advanced courses. Participation by that school’s students in the districtwide science fair had risen substantially. Most important of all, the typical gains in “facets understanding” of these learners were the highest in the district; whereas they started at a low level of scientific comprehension, with many misconceptions, by the end of the curriculum students had improved their understanding dramatically.

In contrast, most of the districts’ other schools used a more traditional curriculum. Their incoming students started with greater scientific comprehension, as expressed in their “facets understanding,” and made some gains over time. In fact, their graduates had overall greater comprehension than the high-performing middle school, which helped to explain the test score

differences. But at all these other sites the gains in facets comprehension during the course of middle school were significantly smaller, and measures of motivation (e.g., participation in the science fair and in optional courses) were falling slowly. Moreover, the gender gap between male and female students' involvement in science and mathematics was widening in every middle school in the district—except the high-performing site with the inquiry-based curriculum.

Martha knew convincing the board that a school at which students had lower test scores was actually their best performer in enhancing educational outcomes would not be easy. Fortunately, she had the data to portray a convincing picture—and to argue that the other schools should alter their curricula to similarly boost their students' gains in understanding and motivation. Fortunately, analogies to input and output analyses in other sectors of society always helped; many members of the community could understand why a coach with less talented players might be named “coach of the year” if that team performed way above expectations. How odd that people had once made decisions based only on educational output, assuming that schools with high-achieving students walking in the door were doing well, simply since their test scores were higher than schools whose students began at lower levels of achievement. This is similar to measuring the relative success of investments by comparing how much money each generated after a year, rather than how much each gained proportionately.

Policymaker

Chief State School Officer Lamont Cranston was preparing for a meeting with the deans of teacher-preparation colleges in his region. He knew that his message would not be a welcome one for some of these institutions. On average, their graduates were performing substantially less well than newly prepared teachers from the other regional education schools. Not only were these teachers' students' gains on multiple measures of educational achievement and motivation generally lower, but also their dropout rate from the profession was significantly higher, particularly for new teachers placed in schools with substantial proportions of at-risk students. Since these underperforming graduates were from some of the richer and more prestigious institutions in the region, the problem seemed to lie in the quality of their preservice preparation rather than the innate capabilities of the new teachers.

More sophisticated forms of assessment had made this type of data analysis possible, enabling multiple complementary measures of teacher effectiveness after controlling for varying student preparations, district expenditures, and curricular approaches. The reliability and validity of these data-based judgments were inadequate for any individual teacher—additional information was needed using appraisals from colleagues—but patterns of aggregate effectiveness for recent graduates from particular educational institutions were clear.

The assessment information also indicated possible causes for why some institutions were doing an inadequate job of preparation. Correlational data linked marginal new-teacher performance to lower levels of field-based experiences in diverse educational settings, to limited exposure to technology-intensive models of inquiry-based pedagogy, and to inadequate preparation in emerging strategies for formative and diagnostic assessment. These correlations were suggestive rather than conclusive, but certainly were worthy of additional study and curricular experimentation. Lamont knew this would not be a welcome message for the Deans. Fortunately,

he had data to back up his claims and to delineate alternative preparation models that might lead to higher overall motivation and achievement by teacher preparation graduates. Also, having state legislators present who were willing to allocate additional resources to institutional participation in “reflective innovation” initiatives would aid his cause.

Implementing Innovative Means of Teacher Professional Development

Of all the stakeholders in the initiatives this report advocates to prepare today’s children for tomorrow’s world, the single most important group is teachers. No educational improvement effort can succeed without building teachers’ capacity to innovate. What types of professional development are central to helping teachers know how to provide students with 21st century knowledge and skills?

Providing Educators with Immersive Experiences in 21st Century Workplaces

Isolated in their classrooms from the rest of society, teachers often have little idea of the skills and knowledge required for adept performance in high-technology workplaces (Dede, 2000). Levy and Murnane (2004) document how:

Declining portions of the labor force are engaged in jobs that consist primarily of routine cognitive work and routine manual labor—the types of tasks that are easiest to program computers to do. Growing proportions of the nation’s labor force are engaged in jobs that emphasize expert thinking or complex communication—tasks that computers cannot do. (pp. 53–54)

These economists go on to explain that “expert thinking” involves “effective pattern matching based on detailed knowledge, and metacognition, the set of skills used by the stumped expert to decide when to give up on one strategy, and what to try next” (p. 75). “Complex communication” requires “the exchange of vast amounts of verbal and nonverbal information. The information flow is constantly adjusted as the communication evolves unpredictably” (p. 94).

Effective teachers engage in expert thinking and complex communication related to instruction so they know about highly skilled work in their own context. However, these skills as applied in a classroom setting with children are quite different than expert thinking and complex communications applied in 21st century workplaces with adults. (This is why skilled workers do not necessarily transition to classroom teaching with instant effectiveness, and why adept teachers may require a period of training and adjustment when shifting careers into workplace roles.) For teachers to model skills of adult thinking and communication to children at a level youngsters understand requires sophistication both about adult performance in workplace settings and about the ways kids understand the world around them. Effective teachers have the latter but need frequent access to and immersion in the economy’s rapidly evolving workplace contexts to keep current with the former.

Society should offer inducements such as government tax incentives to high-technology businesses and other global companies as a means of encouraging summer internships for teachers so they can experience first-hand the types of knowledge and skills students need for 21st century work and citizenship. (Teachers cannot prepare students for a future economic context that they themselves do not understand.) In addition, state teacher standards should incorporate explicit, sophisticated performances in analyzing the impact of advanced information technologies in the workplace and in society as a whole.

As one step in this direction, “Linking Learning to Life” is a nonprofit organization developed to provide a “hands-on learning experience” for teachers in Vermont businesses (Linking Learning to Life, 2005). This initiative creates opportunities for educators and employers to create and strengthen business-school partnerships through a six-week summer program that places teachers in business doing meaningful project work, followed by a yearlong commitment of both school and employer to enhance student learning. In a related effort, the “Linking Learning to Life” program also provides a model by which participating businesses can offer opportunities to students through student internships during the school year, summer employment, job shadowing through following employees for a half day in their workplace setting, classroom presentations by business professionals, and educational tours of workplaces. As other examples, a number of similar programs offer shorter, less comprehensive internships for teachers in local business, lasting days or a few weeks (e.g., Business Education Council of Niagara, 2005; Institute for Enterprise Education, 2005).

While worthy, such efforts rely on good will from both educators and business professionals and necessarily are circumscribed in many ways by this limitation. Much stronger incentives for education and business to participate in sustained involvement by teachers in 21st century workplaces are needed. Mechanisms by which business-education-policymaker partnerships can act to enhance teachers’ understanding of and modeling in their instruction the skills and knowledge required for adept performance in high-technology workplaces might include:

- New Economy Fellowships for K–12 teachers that would provide real-time exposure to business and a better understanding of the skills their students will need to succeed in a changing economy.
- Substantial monetary awards (e.g., Golden Apple) for teachers who create and implement curriculum and best practices that directly address the changing nature of work and the link between higher-order thinking skills and high-paying New Economy jobs.
- Recognition (nonmonetary) and publicity for businesses that engage in programs to assist teachers who develop curriculum and best practices directly addressing the changing nature of work and the link between higher-order thinking skills and high-paying New Economy jobs.
- A New Economy Learning Tax Credit for business linked to business sponsorship of programs that assist K–12 schools in transforming student learning.

Initiatives such as these would provide incentives for business and education to work collaboratively in ensuring that teachers have periodic immersive experiences in 21st century workplaces.

A Special Note Regarding School Counselors

Most often, school counselors are former classroom teachers who have had significant extra training and earned additional certifications. One cannot assume, however, that their experiences adequately have prepared them to help their advisees consider emerging career options and select the appropriate offerings for strong preparation. In many cases, counselors are relegated to routine administrative tasks that have little to do with serving as advisor to their hundreds of students. It is essential that counselors have the same development experiences as other teachers and administrators so they can be effective partners and leaders in program development and implementation.

Improving State Policies for Teacher Education and Professional Development

Beyond teacher internships in sophisticated workplace settings as a way of gaining knowledge about 21st century skills, state teacher standards should include explicit, sophisticated performances involving collaboration with peers, experts, and students to create, share, and master knowledge using sophisticated interactive media. (Teachers cannot prepare students to use knowledge networking skills unless they possess and use those skills themselves.) Further, state teacher standards should integrate explicit, sophisticated performances in using project-based pedagogy to help students address complex real-world problems through a deep mastery of core content; higher-order cognitive, affective, and social skills; and advanced computers and telecommunications. (Teachers cannot effectively use technology-based guided inquiry, collaborative learning, and telementoring in classroom settings unless they have received preparation and modeling for how to implement these sophisticated pedagogies.) How can new models of teacher professional development aid in achieving these ambitious objectives?

Empowering Teachers Via Technology

The Milwaukee Public Schools' (MPS) sophisticated infrastructure is used to empower teaching and learning through a number of district initiatives. One element of MPS's PT3 grant was the creation of a National Technology Advisory Board. Two high-profile national leaders, Chris Dede, from Harvard University, and John Morgridge, from Cisco, agreed to serve as cochairs and in turn persuaded other national leaders in educational research and in business to join them in support of Milwaukee. The board's discussions rapidly focused on two core issues impeding learning in MPS: the lack of active participation by district curriculum leaders in technology innovation efforts, and the high turnover among new MPS teachers. Two initiatives were highlighted as crucial to resolving these issues: the Curriculum Design Assistant and the Professional Support Portal.

Curriculum Design Assistant. The MPS Curriculum Design Assistant (CDA) (mpscda.milwaukee.k12.wi.us) is a tool that emerged from MPS work with Replicable Schools as initial test beds. Teachers are asked to blend many agendas into meaningful student work as various directives reach teachers from the state, the district, professional organizations, their principal, the community, colleagues, and their union. Conventional district curriculum support operations were having little impact in helping teachers with these many agendas. To aid with this situation, the CDA creates a collaborative environment where teachers are able to post and

find lessons that support their day-to-day work in classrooms. This tool is Web-based and is accessible 24 hours a day. When used in the creation mode, the CDA guides its users through lesson design options that are research proven, searchable, and standards-based. State and district standards are readily available in the lesson-design process wherever and whenever the work is taking place.

Early challenges for the CDA included developing a set of “blue ribbon” lessons that would draw teachers to this tool. Replicable School staff, whose idea this was initially, were eager to feature their work through the CDA and began to develop the collaborative community they envisioned. The superintendent and senior staff of the district recognized the potential of the CDA and provided early endorsements for this tool as a pivot point that could unify district curriculum messages for schools and teachers. Members of the Milwaukee Board of School Directors participated in a CDA workshop so that they would understand this tool and the broadening base of support that was developing.

District inservice experiences were designed to support teachers embedding lessons into the CDA. Executives from the teachers union also were trained in the use of the CDA. They quickly recognized that this was a practice they could support because it advanced effective teaching and did not place their constituency at risk. MPS teachers began featuring their work with the CDA in professional meetings across the state and nation.

Combinations of strategies were used to scale up the use of the CDA. A PT3 catalyst grant from the U.S. Department of Education was awarded to MPS to assist with this process. Three universities (the University of Wisconsin–Milwaukee, Marquette University, and National-Louis University) were awarded companion PT3 implementation grants to build upon the CDA work in MPS. Through these funds, faculty from local colleges and universities were trained in the use of the CDA. The CDA was made available for these universities to use as part of their preservice development programs.

Other school districts in Wisconsin, and other teacher preparation programs, also were provided access to the CDA with the capability to develop a customized view for their school district. Partnership districts along with MPS grant activities have populated the knowledge base with an increased number of standards and project-based lessons integrating various levels of technology and current research proven instructional strategies. Districts have artifacts of growth, change, and movement towards meeting NCLB requirements through peer-reviewed instructional plans. Representatives of the Wisconsin Department of Public Instruction were trained in the features and functions of the CDA. As a culmination, and prompted by the legislative mandates of NCLB, this demonstration tool was upgraded to a production tool by MPS to support a full-scale implementation.

The biggest challenge has been to get the people tasked with curriculum leadership at the district level to utilize the CDA. They have lagged in their adoption of technologies that support their work and have relied on old methodologies. Organizational tension increased as more schools began employing the CDA in their curriculum alignment and practice. A recent change in district leadership for this area has helped with the alignment of efforts and change in practices.

Professional Support Portal

Students' success is largely dependent on the effectiveness of their teachers. Since more than 10 percent of MPS teachers leave each year, and 37 percent of MPS new teachers leave within their first five years, unacceptable instructional conditions result. Students, often those with the greatest needs, are being taught by rookies year after year. What roles can technology play to advance and accelerate the effectiveness of new teachers as well as reduce the attrition among new teachers? These questions are driving a major Professional Support Portal (PSP) initiative (mpsportal.milwaukee.k12.wi.us).

MPS spent several months conducting focus groups, asking approximately 50 new teachers about their initial experiences. They identified a host of issues that represented barriers to early success. New teachers also identified district supports worth retaining and indicated that, if some technology-based tools were made available, this could help alleviate some of the problems. These findings were shared with key leaders in the district who readily endorsed seeking resources to build a MPS Portal.

New teachers' needs center on access to high-quality teaching and information resources, frequent interaction with expert mentors and coaches, and ongoing peer support. In response, the portal project has created a convergence of several technology initiatives:

- The CDA provides a ready-made tool for teachers to interact about instructional strategies, resources, and curriculum alignments.
- Teachscape[®], a commercial professional development process based on video case studies, provides examples of standards-based lessons being taught in urban classrooms at the elementary level (ts2.teachscape.com/html/ts/public/).
- TappedIn[®], a nonprofit MUVE for professional development, provides an online social context that allows educators to build and sustain communities of practice (www.tappedin.org).

A prototype model of the portal was constructed, and formative design feedback from new teachers was collected and analyzed. Design feedback and communication needs were identified and prioritized in order to search and procure a scalable tool in which to create the portal environment.

A tool was selected and resources for an implementation team to work collaboratively with an MPS Portal Team were put in place. In a six-month period, the information tree, basic communication infrastructure, and design were completed. In May 2004, the initial presence was delivered to MPS school administrators. During summer 2004, content and features for teachers and new teachers were added. Access to all MPS staff was opened in September of 2004.

In Year 1 of its delivery, the MPS Portal gained an average of 400 unique and new users per month and lost approximately one third. Data indicates that lack of content is the main reason for a user not to return. In an effort to move forward, the district has begun a strong effort to eliminate prior practices and move information and communications to PSP. The district has developed a work plan with milestone goals so that by January of 2006, a school administrator or

teacher will have access to the information necessary to work efficiently and effectively. The district will continue ongoing training, alignments, and work toward building professional learning communities through online technologies and face-to-face meetings.

A cadre of teacher leaders has been established and continues to grow. Twenty-five teacher leaders are now certified as portal trainers and portal support. Administrative-level leaders are now being groomed to carry on the model within their own peer group. While the goal of the project was to put in place a tool that would require little or no training, it was discovered that professional discourse and support are needed to make use of the information meaningful. While a new user arrives thinking he or she needs to learn how to use a new software application, what soon is discovered through collaboration with others is the reintroduction to professional interactions, networking, and contributions back to their practice.

Community management teams have been established in the priority communities of (1) school administration, (2) teachers and new teachers, and (3) special education. These teams meet with their own groups and then feed into an overall structure. This practice has grown, helping drive the content development and the delivery in usable, just-in-time, accessible access for users. The teams also have provided the definitions necessary for further clarity and identification of additional district information to be integrated into PSP.

Through funding from the Joyce Foundation, a team of Harvard University and EDC experts assisted MPS staff with design and implementation of the PSP. Using broadband telecommunications, Internet-based videoconferencing, and collaboration tools, this team provided:

- Online courses customized by EDC for MPS staff in a cross-section of leadership roles across the district, centering in 2002–03 on the use of new interactive media in professional development and on data-based decision making. These courses evolved into a full range of professional offerings (38 aligned curriculum workshops offering graduate credit) for MPS teachers and nonpublic teachers in Milwaukee. Four cycles per calendar year are offered with enrollments of approximately 250 teachers in each cycle.
- Harvard faculty guidance (via videoconference) during 2002–03 for a cohort of “rising star” MPS principals, who completed the Harvard Principal’s Institute in Cambridge, Massachusetts, the previous summer providing feedback on their attempts to implement leading-edge practices in local settings. Principals who participated in this experience have assumed peer-leadership roles for defining the School Administration Community and in using PSP as a tool in their own buildings.
- Groupware and videoconference-based collaborative design of the PSP using interface and knowledge management specialists at Harvard. Use of these tools has become a standard operation in some MPS departments as a way to engage with others internally and externally.
- Consultations with an expert in program evaluation helping design metrics for assessing the complex, interwoven set of activities associated with PSP. The formative evaluation component has been expanded and now includes a researcher as a member of the implementation team who is helping identify trends, needs, and successes. This is key in

helping develop the steps needed to conduct the strategic planning, support acceptance of change, and the success of future implementation. Formative evaluation also helps recognize and report progress sometimes hidden from view because of the complex nature of this work.

- Analysts who are documenting the process by which PSP is being created and implemented.

From a research perspective, the Harvard team is studying the extent to which broadband and Internet2 interactive media can support these complex activities across distance without the necessity of making frequent trips to Milwaukee.

The PSP project is having a significant impact on many departments and divisions in MPS. As content is being embedded in PSP, underlying problems at the district with fragmentation of practices and procedures is becoming apparent. In most cases, administrators are viewing this as an opportunity to improve practices, but some people would rather not bother, as working in silos can be comfortable and less complicated. However, district leaders are providing strong support for organizational alignment around PSP.

The ongoing struggle of facing how existing practices may hinder success is being waged. District leaders are supportive in concept but are frustrated with a limited understanding of PSP and the changes in practice being driven by PSP implementation. The complexities of organizational structure and practices are fleshed out as necessary information structures are identified for PSP implementation. Areas of operations that have gone for years without engaging in strategic planning are now expected to participate. Sometimes they need strong encouragement, and assistance is provided to help them move forward. Many district-level support groups equate their difficulty to contribute content and interact with others as “PSP-related,” when in fact it has become clear that it is still an issue of limited technology skills. Previous ventures of professional development and training were aimed at classroom teachers who are now ready and waiting for the accessibility and interaction through PSP. The district is above average in teacher technology capacity and now must address the needs of those who support teachers, including clerical, administrative, and business operations. At times this can be daunting and overwhelming. District leadership is trying to move forward one step at a time in order to sustain momentum.

As noted earlier, of all the stakeholders in the initiatives this report advocates to prepare today’s children for tomorrow’s world, the single most important group is teachers. No educational improvement effort can succeed without building teachers’ capacity to innovate. What types of professional development are central to helping teachers know how to provide students with 21st century knowledge and skills?

Developing Online Learning Communities for Educators

As the Milwaukee Public Schools Professional Development Portal illustrates, emerging devices, tools, media, and virtual environments offer opportunities for creating new types of learning communities for teachers (Dede, 2004). According to Bielaczyc and Collins (1999):

The defining quality of a learning community is that there is a culture of learning, in which everyone is involved in a collective effort of understanding. There are four characteristics that such a culture must have: (1) diversity of expertise among its members, who are valued for their contributions and given support to develop, (2) a shared objective of continually advancing the collective knowledge and skills, (3) an emphasis on learning how to learn, and (4) mechanisms for sharing what is learned ... This is a radical departure from the traditional view of schooling, with its emphasis on individual knowledge and performance, and the expectation that students will acquire the same body of knowledge at the same time.

Professional development processes based on “learning communities” mirror the shifts desired in educational practice, moving from passive assimilation of information to active construction of knowledge, so the innovation process is consistent with its content (Dede, 2001a).

Many groups have experimented with learning communities for teachers and students confined to classroom settings and centered on the instructor and archival materials (in libraries and online) as the primary sources of knowledge. Transformational learning of 21st century skills instead requires a bolder strategy of infusing learning communities throughout students’ and teachers’ lives, orchestrating the contributions of many knowledge sources embedded in real-world settings outside of schools—but with teachers still in a central role as facilitators and interpreters.

Furthermore, a major challenge in professional development is helping teachers “unlearn” the beliefs, values, assumptions, and cultures underlying schools’ standard operating practices. Altering deeply ingrained and strongly reinforced rituals of schooling takes more than an informational interchange of the kind typical in conferences and “make and take” professional development. Intellectual, emotional, and social support is essential for “unlearning” and for transformational relearning that can lead to deeper behavioral changes to create next-generation educational practices (Dede, 1999).

“Distributed learning” is a term used to describe educational experiences distributed across a variety of geographic settings, times, and interactive media. Professional development via distributed learning involves an orchestrated mixture of face-to-face and virtual interactions, often centered on a “learning communities” model. Research shows that, in general, the integration of interactive media into student instruction or teacher professional development shapes the learning experiences of those involved (Dede, Whitehouse, & Brown-L’Bahy, 2002). Many participants in distributed learning situations report that the use of asynchronous learning environments (such as threaded online discussions, which do not rely on posting at the same time for interaction) positively affects their participation and their individual cognitive processes for mastering knowledge and skills. In addition, participants indicate that synchronous virtual media (e.g., chat rooms, interactive media requiring posting simultaneously) help them get to know members of the learning community with whom they might not otherwise individually interact and also provide a clear advantage over asynchronous media in facilitating the online work of small groups.

Learning communities based on distributed-learning strategies (“distributed-learning communities”) are a powerful mechanism for this type of knowledge diffusion. Professional development initiatives should include all information necessary for successful implementation of an exemplary practice, imparting a set of related innovations that mutually reinforce overall systemic change. Distributed-learning communities provide a vehicle for this type of rich knowledge adaptation. Thus, our vision for educational improvement is based on a multilayered model of distributed-learning communities that aid educational practice, professional development, and the transformation of schooling to foster 21st century knowledge and skills.

Exemplars of Online Teacher Professional Development Programs

Illustrative, exemplary teacher professional development initiatives based on distributed learning communities and oriented to higher-order skills for teaching, learning, and leading include:

- The Inquiry Learning Forum at Indiana University seeks to improve student learning by supporting teachers in better understanding inquiry-based teaching and learning. Teachers can connect and interact with other teachers, share inquiry-based lesson plans and resources, see videos of inquiry-based classrooms, and develop their own personalized professional development plans. (ilf.crlt.indiana.edu)
- Widescale Interactive Development of Educators (WIDE) World focuses on professional development of constructivist teaching practices for schools and other settings. WIDE World offers semesterlong professional development courses in which participants learn about research-based pedagogies, apply these principles in designing and enacting new approaches with their own students, receive frequent support and feedback from a coach, and engage in regular reflective exchanges with fellow participants in the course. (wideworld.pz.harvard.edu)
- The eMentoring for Student Success (eMSS) project establishes online networks for beginning and experienced science teachers and scientists. These networks are designed to promote professional development through dialogue. eMSS provides online mentoring for beginning science teachers by trained mentors who teach the same discipline, facilitated online modules to focus on science content and pedagogy that directly applies to the teacher’s classroom, access to scientists to explore content, and leadership training for mentors, facilitators, and scientists. (newteachercenter.org/emss/)

Many of these models for teacher professional development generalize to building leadership capacity in all types of educators.

Identifying Conditions for Success

Simply having access to current technologies in schools was not sufficient to create the transformation to more effective learning experiences. Numerous national projects sought to encourage development and transformation, including the CEO Forum, Technology Literacy Challenge Fund, Preparing Tomorrow’s Teachers to Use Technology, Star Schools, Technology Innovation Challenge Grants, the National Commission on Teaching for America’s Future, and Four Pillars. These projects effectively targeted key elements to begin the transformation of educational practice. Two things were clear:

1. Things people described as outcomes from the infusion of technology into the learning process had never been done before, and certainly not at a national scale. Thus, innovation had to be a developmental process.
2. Creating the transformation could not happen in the abstract. People had to have access and opportunity to learn the capabilities of the technologies so they could then begin to consider how they could be used to enrich learning experiences for children.

What also became clear was the impatience to see concrete results at the local level, especially on the standardized test scores of children. Let's not continue to make the mistake of using only 20th century measures to assess the millennial children and believing that those tests measure all important and critical knowledge and skills.

A parallel, companion component is a set of integrated management systems designed to increase efficiency and effectiveness for teachers, principals, and district personnel. Educators can learn many lessons from business and industry, which in this area are technology-generations ahead of schools. While technology in the for-profit sector initially was applied to increase efficiency for routine processing (e.g., payroll, accounts payable, inventory control), today businesses routinely use technologies as part of their core business functions to increase productivity. For example, the time required for product development cycles has shortened dramatically. Yet, these strategies, for the most part, have not yet migrated into the core business of education; that migration should be intentional and purposeful.

Most smaller and rural school districts have neither the capacity nor the resources to embed technologies into the core business of education. Regional approaches provide an opportunity to mitigate the limitations experienced by smaller or rural districts. Each individual district has strengths in specific areas; combining the strengths of districts across a region creates opportunities to develop effective solutions and strategies for transforming to 21st century learning.

Developing Transformational Strategies for Evolving Teaching, Learning, and Schooling

Other technologies also are accelerating the transition from private to public practice. For example, interactive video enables engaging classrooms from remote locations. Master teachers when in this setting effectively can serve multiple audiences. When a group of preservice teachers is able to observe real-time performance by real teachers from their college classroom, theory can be seen in its application. Dialogue before and after observations between the preservice students and the master teacher are extraordinarily effective for engaging preservice students and helping them gain a vision of professional practice.

Because modern interactive video uses the Internet rather than digital phone lines, access is not limited to costly studio settings. Homebound students using a modest investment can "attend" class in the same way as the preservice students. Parents can discretely observe their child at work in his or her classroom. Teachers can engage in inservice activities that feature the most effective grade-level or subject-area teachers and instructional strategies and methodologies.

These same networks also can be used for security surveillance. Overall, all these developments are creating a transition from private to public practice.

Building Scalable, Sustainable Models Adaptable Across Organizations

As discussed earlier in the section on “Strategic Investments in Educational Research,” scaling up involves adapting an innovation successful in some local setting to effective usage in a wide range of contexts. In contrast to experiences in other sectors of society, scaling up successful programs has proved very difficult in education (Dede, in press). Insights from changing operations at one fast-food location may transfer easily to every store in that franchise and perhaps to any comparable type of restaurant. However, a new type of teaching strategy successful with one practitioner often is difficult to generalize even to other instructors in the same school let alone to a broad range of practitioners. Scalable designs for educational transformation must avoid what Wiske and Perkins (2005) term the “replica trap”—the erroneous strategy of trying to repeat everywhere what worked locally, without taking account of local variations in needs and environments. This involves resolving problems of magnitude (fostering the necessary conditions for change in large numbers of settings with average resources at considerable distances from one another) and variation (diverse and often unfavorable conditions across settings).

In the context of innovations in teaching and curriculum, Coburn (2003) defines scale as encompassing four interrelated dimensions: depth, sustainability, spread, and shift in reform ownership. “Depth” refers to deep and consequential change in classroom practice, altering teachers’ beliefs, norms of social interaction, and pedagogical principles as enacted in the curriculum. “Sustainability” involves maintaining these consequential changes for substantial periods of time. “Spread” is based on the diffusion of the innovation to large numbers of classrooms and schools. “Shift” requires districts, schools, and teachers to assume ownership of the innovation, deepening, sustaining, and spreading its impacts. A fifth possible dimension to extend Coburn’s framework is “evolution,” in which the innovation as revised by its adapters is influential in reshaping the thinking of its designers, creating a community of practice that evolves the innovation.

Beyond fostering the types of research centers discussed earlier, how can intersector organizational structures among business, government, and education for scalable, linked economic and educational development develop initiatives that “scale up?” The answer to that question may lie in the evolutionary model of economic development planning that has pushed the formation of regional and multistate organizations. In a complex, global economy, smaller geographic units (towns and cities) are unable to effectively address large complex issues such as waste treatment, water resources, transportation, and workforce training. Faced with these large-scale issues that require scalable solutions, smaller geographic units have been driven to form regional authorities or planning bodies to create solutions to large problems.

In the area of economic development, K–12 schools have not been incorporated into most of these regional models. Yet these schools are a critical gateway for the education and training of the workforce. Certainly some “school-to-work” programs begin to address this, but no substantial effort exists to build a comprehensive model that links K–12 to the core of economic development.

There are many historical examples of this sort of linkage at the university level. Land grant universities were established in the 1860s as a key partner in making agriculture and manufacturing more efficient and competitive. Following World War II, the GI Bill created the educated workforce needed to continue to develop the postwar mass production economy. Something on this scale is needed today to create the economic link between education and sectors involved in business, economic planning and workforce development.

Conclusions

This report’s objective is to stimulate dialogue and debate about the true nature of the challenges U.S. education faces and the exciting ways ICT could aid in meeting those challenges. The New Economy is changing our world dramatically and is having a profound impact on the future of today’s children. Many nations, recognizing this, view innovation via sophisticated information technologies and educational investment as the two keystones to advancing prosperity and quality of life for their citizens. These countries understand that information and communications technologies, when embedded in core business processes, enable great improvements in effectiveness. Beyond building an information infrastructure for business, our global competitors are investing in ICT for education, both to prepare their children for the global, knowledge-based workplace and to increase the effectiveness of teaching and learning.

Despite our wealth and knowledge, the United States is not linking investments in education, economic development, and ICT. Instead, individual communities are mired in 20th century business and educational practices no longer functional in a “flat” world (Friedman, 2005b). This country and its regions need to engage collaborations of business, education, community, and policy leaders to meet the opportunities and challenges posed by a New Economy. Such a strategy can draw upon the collective strengths of regions to develop visions based on local strengths and to adapt the ideas and recommendations in this report to every local school and classroom across the region. As part of this process, ICT investments are vital to create a catalyst that can unleash the creativity of educators, students, and communities working to implement these new visions. Through the approaches this report proposes, a network of regions across our nation can set next-generation standards and enrich the framework set by the Partnership for 21st Century Skills. The nation must act boldly and immediately to prepare today’s children for tomorrow’s world—otherwise, we are mortgaging the futures of generations to come.

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Appendix A

Kozma (in press) describes the economic and social opportunities created by the advance of information technology:

The production, distribution, and use of new knowledge and technological innovations have been major contributors to increased productivity, the upgrade of physical capital, and the creation of new, high-value-added jobs. Increases in human, institutional, and technological capabilities are, in turn, major sources of new knowledge and innovation. From this perspective, technological innovation and new knowledge are both the engine and the product of economic growth. Consequently, investments in research and development and technological innovation can create new knowledge that spawns a virtuous cycle of growth... As information and communication technologies—including laptops wirelessly connected to the Internet, cell phone-web browsers, personal digital assistants, and low-cost video cameras—become more accessible and embedded in society they offer the potential to restructure organizations, promote knowledge sharing, increase democratic participation of citizens and the responsiveness of governmental agencies, make education and health care more widely available, to foster cultural creativity, and enhance the social integration of individuals with different abilities and groups of different cultural backgrounds.

Based on this, Kozma (in press) provides a framework for information and communication technology (ICT) based educational, social, and economic development:

Table 1
Development Framework
Growth Factors and Types of Development

	Economic Development	Social Development	Educational Development and Educational ICT	
Physical Capital	Identify cluster & develop cluster-friendly infrastructure; private capital deepening.	Build hospitals & social service facilities; build CTCs; support private acquisition of ICT; facilitate Internet cafes.	Build and improve school facilities.	Acquisition of school ICT equipment & networking.
Human Capital	Upgrade labor, develop technology use & application skills & knowledge production skills; develop collaboration and entrepreneurial skills and innovativeness.	Provide social services supplemented by civil society and increased community participation & community knowledge building skills; develop skills in collaboration,	Redesign curriculum to develop students' knowledge building & application skills, complex problem solving, creativity, collaboration skills. Upgrade	Develop students' skills in using ICT to solve real world problems. Develop teachers' skills in ICT use & integration into the curriculum.

		communication, ICT use.	teachers' content & pedagogical knowledge, innovativeness.	
Production, Knowledge, & Technological Innovation	Establish good macroeconomic climate; shift to high value-added clusters; support invention of new products & services & the production of knowledge & technological innovations; invest in R&D.	Production of community knowledge, cultural products and performances.	Pedagogy focused on knowledge building, collaborative problem solving. Codify local knowledge on effective teaching practices. Support continuous innovation.	Use of ICT tools and collaborative environments for collaborative knowledge building and the application of knowledge to solve complex problems and produce cultural artifacts.
Organizational Structure & Networking	Develop participation of SMEs; agglomeration of enterprises, support modularity & flattening of structures; networking & sharing.	Networking & knowledge sharing within community & civil society; open government & education organizations to community & parent participation.	Decentralize decision making; foster professional development communities; increase teacher authority; support networking & knowledge sharing; extend school boundaries.	Use of ICT to support communication, collaboration & community building; open boundaries of the education system.
Monitoring & Evaluation	Monitor effectiveness of government policies on economic indicators; encourage high production standards, continuous monitoring and improvement; monitor customer needs & impact of products & services.	Monitor effectiveness of government policies on social indicators; obtain community feedback.	Monitor school effectiveness & accountability; encourage high standards for students. Assessment focused on application of knowledge to solve problems.	Use of ICT to support organizational effectiveness, efficiency; use in assessment.

Appendix B

Regional commissions would include the business, education, and government sectors. What follows are some ideas on how an EE2025 might come about and on an agenda that such a Commission might undertake.

Launching an EE2025 Commission

- Recruit executive, intersector leaders to serve as core sponsors for building long-term relationships that focus on improving the quality of life for families across the region through educational and economic development.
 - The core sponsors would serve as the EE2025 champions and spokespersons for their region.
 - The core sponsors would establish the EE2025 Commission, its membership and its governance structure.
 - The core sponsors would establish the strategic agenda for EE2025.
 - The core sponsors would take responsibility for identifying the individuals charged with operationalizing EE2025 initiatives.
- The EE2025 Commission would become the primary strategic planning entity for the region.
 - The EE2025 Commission would sponsor alignment of efforts among established agencies and organizations.
 - The EE2025 Commission would sponsor intersector collaborations.
 - The EE2025 Commission would feature and celebrate effective practice models engaged in the Commission's agenda.
 - The EE2025 Commission would sponsor research projects that further the Commission's agenda.
 - The EE2025 Commission would seek resources to encourage transformational development.

Establish Vital, EE2025 Sponsored Educational Initiatives

The Commission would assume a pivotal role in regional planning and development, capitalizing on powerful new strategies emerging from the intersection of economic and educational development. Vital educational initiatives offering strategic long-term benefits would include:

Preparing Students for 21st century Work and Citizenship

- Policymakers should act on recommendations for student learning from the Partnership for 21st Century Skills (Road to the 21st Century, pp. 18-20):

- Adopt state standards that incorporate 21st century tools and learning skills as part of the No Child Left Behind eighth-grade technology literacy requirement.
- Alter current state standards, curricula requirements, and assessment measures to embed ICT literacy into core subjects.
- Communities should build social safety nets for children that support their learning and growth outside of school.

Helping Teachers and Principals Prepare Their Students for 21st century Work and Citizenship

- Promote professional development initiatives ensuring that teachers and administrators have periodic immersive experiences in 21st century workplaces:
 - New Economy Fellowships for K–12 teachers that would provide real time exposure to business and a better understanding of the skills their students will need to succeed in a changing economy.
 - Substantial monetary awards (like the Golden Apple awards) for teachers who create and implement curriculum and best practices that directly address the changing nature of work, showing the link between higher-order thinking skills and high-paying New Economy jobs.
 - Recognition (nonmonetary) and publicity for businesses that engage in programs to assist leading edge teachers linking education and economic development.
 - A New Economy Learning Tax Credit for business linked to business sponsorship of programs that assist K–12 schools in transforming student learning.
- Enact state policies for teacher professional development on 21st century learning:
 - State teacher standards should incorporate explicit, sophisticated performances in analyzing the impact of advanced information technologies in the workplace and in society as a whole.
 - State teacher standards should include explicit, sophisticated performances involving collaboration with peers, experts, and students to create, share, and master knowledge using sophisticated interactive media.
 - State teacher standards should integrate explicit, sophisticated performances in using project based pedagogy to help students address complex real world problems through a deep mastery of core content; higher order cognitive, affective, and social skills; and advanced computers and telecommunications.
 - States should create, support, and sustain innovative professional development environments for teachers that combine face-to-face learning experiences with participation in virtual learning communities.

Building a Cadre of Business, Policy, and Education Leaders

- Provide incentives for universities to develop programs that educate business, policy, and education leaders to understand the relationship between effective K–16 programs and powerful economies.

- Provide incentives to foster EE2025 partnerships among the business, education, and policy sectors at the local, state and regional levels.

Creating a Standards-Based Technology Infrastructure

- Provide a high-quality technology infrastructure to all students, teachers, and administrators:
 - Extend federal initiatives such as the e-rate program and state initiatives that encourage 1:1 computing access.
 - Create regional telecommunications networks that link educational institutions, other social services organizations, businesses, and the policy sector.
 - Provide sophisticated technology-based media and curricula that build on students' neomillennial learning styles.
 - Provide advanced analytic tools and integrated management systems for data-based decision making, making teaching and learning a public practice.

Sponsoring Research

- Conduct an assessment of regional policies with regard to educational technology using planning tools, such as Dede's state education policy framework (2001b).
- Increase business, philanthropic, federal, and state funding for research that applies theoretical insights and advanced analytic methods to practical problems in education.
- Create and sustain regional research centers and institutes to develop transformative innovations for teaching, learning, and leadership that build on the power of sophisticated information technologies.
- Fund implementation test beds to study ways to scale up local successes in education.